University of Kentucky®
Procurement Services

INVITATION FOR BIDS

UK-2563.30-8-25
Cancer Treatment Center
BAS Controls
ADDENDUM #1
10/02/2024

IMPORTANT: BID AND ADDENDUM MUST BE RECEIVED BY: 10/10/2024 @ 3:00 P.M. LEXINGTON, KY TIME

Bidder must acknowledge receipt of this and any addendum as stated in the Invitation for Bids.

ITEM #1: Questions & Answers and Modifications and Clarifications to the Bid Documents:

- Bidders are instructed to review and incorporate into their offers the attached addendum#1 from Walsh Construction Group and associated files.
- The "Group 3 drawing set" is posted in the UK Plan Room and is not included in this document as the file(s) are too large.

OFFICIAL APPROVAL
UNIVERSITY OF KENTUCKY

10/02/2024

Ken Scott

Ken Scott / (859) 257-9102

SIGNATURE

_____

_____
Typed or Printed Name

University of Kentucky
Procurement Services
322 Peterson Service Building
Lexington, KY 40506-0005

CHAMPLIN
ARCHITECTURE

Addendum #01

Client	University of Kentucky Healthcare	Date	09/30/2024
Project	Cancer Treatment Center BAS Controls	UK Project #	2563.3
Solicitation #	UK-2563.30-8-25	Champlin Project #	514-6926

This addendum provides information to clarify or adjust construction items which may affect any or all trade contractors. The original documents for the referenced project are amended as noted in this addendum and made part of said documents and shall govern the work covered by the Form of Proposal. All work to be in strict accordance with the terms, stipulations and conditions of contract documents.

CLARIFICATION:
Drawings with revision clouds have changes as described below.

SUMMARY OF ATTACHMENTS

PART A - DRAWINGS:

IC100 – MECHANICAL CONTROLS – LEVEL 00

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."*
2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC101 – MECHANICAL CONTROLS – LEVEL 01

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."*
2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC102 – MECHANICAL CONTROLS – LEVEL 02

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE*

PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."

2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*
3. *Revise note IC29 to read "MEDICAL GAS MANIFOLD SCALES TO BE INTEGRATED AND MONITORED BY THE BAS VIA BACNET OVER MSTP CONNECTION. IF LOW WEIGHT IS DETECTED AN ALARM SHALL BE SIGNALED TO THE BAS."*

IC103 – MECHANICAL CONTROLS – LEVEL 03

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."*
2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC104 – MECHANICAL CONTROLS – LEVEL 04

1. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC105 – MECHANICAL CONTROLS – LEVEL 05

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."*
2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC106 – MECHANICAL CONTROLS – LEVEL 06

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."*

2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC107 – MECHANICAL CONTROLS – LEVEL 07

1. *Revise note IC17 to read "REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER."*
2. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS."*

IC108 – MECHANICAL CONTROLS – LEVEL 08

1. *Revise note IC26 to read "ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK"*

IC208 – MECHANICAL CONTROLS

1. *Refer to bubbled changes on sheet.*

IC209 – MECHANICAL CONTROLS

1. *Refer to bubbled changes on sheet.*

IC210 – MECHANICAL CONTROLS

1. *Refer to bubbled changes on sheet.*

IC212 – MECHANICAL CONTROLS

1. *Refer to bubbled changes on sheet.*

IC300 – MECHANICAL CONTROLS - SCHEDULES

1. *Refer to bubbled changes on sheet*

PART B - SPECIFICATIONS:

Revised Table of Contents

Section 232923 – Variable Frequency Motor Controls

1. *New Section.*

Section 250200 – Instrumentation and Control for HVAC – UK Standards

1. *New Section.*

Section 250300 – Energy Meters

1. *New Section.*

PART C – RESPONSES TO BIDDER QUESTIONS:

See project team responses to bidder questions.

PART D – EXHIBITS

None.

Part E – SKETCHES

See BP-7 Group 3 To Bid Drawings and Combined Specs for Coordination and Reference.

PART F – UPDATED BID FORMS

None.

End of Addendum

Controls RFP Question and Response Log Respones As Of: 10/2/2024 @ 8:00 AM Through RFI # 86				
#	Question	Responder	Response	Release
1	Note I26 on multiple drawings calls for the controls contractor to provide and install building lighting controls panel. But in the RFP and on IC210 there is mention of a "lighting control vendor". Would the lighting control vendor not provide the lighting control panel and the controls contractor just integrate to that panel? Is the lighting control panel not going to be integrated via BACnet IP? Aren't BACnet IP integrations handled directly by UK's controls group?	AEI	Lighting Control Panels will be provided by the Electrical Contractor. The control panels will require integration with the BAS system for timeclock controls (provided by Controls Contractor)	
2	Is this intended to be bid like Health Education Building where it is one bid for the controls for the whole building, core & shell and Fit-Out? Or is this just intended to be a Core & Shell bid?	Walsh	This is for the entire building, not including the parking garage. The parking garage is a separate project.	
3	There appears to be IC drawings pages 441-465. But these are labeled as "C&S 100% DD Review" and I do not see any IC drawings for the Fit-Out.	CMTA	The C&S 100% DD Review is in the previously issued section. That was the first time the controls IC drawings were included in a set. However, there is no different core and shell set vs fitout set. This bid is to include all work on both bid packages. Note that the IC drawings contain all of the fitout.	
4	if this is just a bid on the Core and Shell controls, what's with all the drawings provided that seem to be for the Fit-Out? These start on page 3357. There does not appear to be any additional drawings to go along with the Core and Shell control drawings (mechanical, plumbing, electrical, architectural, etc).	Walsh	See response to question 3 above and note all of the fitout information included in the IC drawing set. In Progress Fit Out Drawing Set was provided for reference to subcontractors as they are assembling their proposal.	
5	1. The stairwell pressurization fans require the related controls to be UL864. Is there a JACE/JACE panel that can meet UL864 compliance? Does UK have an example of this anywhere else on campus for reference?		Yes there is a UL 864 jace on the market from Distech or this could be tied into any approved tier 2 device that is UL 864 listed.	
6	2. Would a Johnson Controls SNE Tier 1 panel that is UL864 compliant be allowed to be furnished in order to meet UL864 compliance for the stairwell pressurization? All tier 1 devices that do not need UL864 compliance can remain JACEs.		No, provide panel from list of approved products per the specifications.	
7	3. Is the BAS contractor responsible for furnishing a fire fighters panel for stairwell pressurization? Or will this be provided by others?		Yes, BAS contractor to provide as shown on the drawings.	
8	4. Can we move the fire fighter panel, UL864 controls, and stairwell pressurization control under the fire alarm contract and the BAS contractor monitor only these controls?		no	

9	Can we move the fire fighter panel, UL864 controls, and stairwell pressurization control under the fire alarm contract and the BAS contractor monitor only these controls?		no	
10	1. On page 232 of the RFP under 7. Scope Clarifications-Scope Specific: Item 20. States that the BAS contractor shall complete the graphics package, in the form of a formal submittal, within four weeks of contract award. Can you please clarify or give more detail as to what this graphics package is? Typically UK does all their own graphics for the BAS. Is this project different?	Walsh	No, UK is providing graphics as is typical for all UK projects. This line item will be corrected prior to issuance of subcontract to successful firm.	
11	2. On page 233 of the RFP under 7. Scope Clarifications-Scope Specific: Item 31 mentions that the BAS contract shall furnish and install thermometers and pressure gauges. Typically actual local read out thermometers and local readout pressure gauges are not provided by the BAS contractor. Temperature sensors and pressure sensors reporting to the BAS are. Please confirm if it is actually intended for the BAS contractor to furnish local read out thermometers and local readout pressure gauges.	Walsh	Correct, gauges are by division 23 contractor and sensors are by the BAS contractor. This line item will be corrected prior to issuance of subcontract to successful firm.	
12	3. On page 233 of the RFP under 7. Scope Clarifications-Scope Specific: Item 31 mentions that the BAS contractor shall install temperature sensor ports, testing ports, controls valves etc required for monitoring or providing alarms per contract documents and sequence of operations. Typically temperature sensor ports/wells and control valves are to be installed by the mechanical contractor. Please confirm that these items are the mechanical contractors responsibility.	Walsh	Confirmed, mechanical contractor will be responsible for installation of ports and welding to pipework for BAS controllers use for placement of sensors.	
13	4. The stairwell pressurization fans require the related controls to be UL864. Is there a JACE/JACE panel that can meet UL864 compliance? Does UK have an example of this anywhere else on campus for reference?	CMTA	There is a UL 864 jace on the market from Distech or this could be tied into any approved tier 2 device that is UL 864 listed.	
14	5. Would a Johnson Controls SNE Tier 1 panel that is UL864 compliant be allowed to be furnished in order to meet UL864 compliance for the stairwell pressurization? All tier 1 devices that do not need UL864 compliance can remain JACEs.	CMTA	No, provide panel from list of approved products per the specifications.	
15	6. Is the BAS contractor responsible for furnishing a fire fighters panel for stairwell pressurization? Or will this be provided by others?	CMTA	Yes, BAS contractor to provide as shown on the drawings.	
16	7. Is the BAS contractor responsible for furnishing the “Water Meter associated with the irrigation water loop for both exterior and interior?” This is on page 235 of the RFP under 7. Scope Clarifications-Scope Specific: Item 55.	CMTA	Yes, the BAS contractor is responsible for this.	
17	8. Regarding the window shade control:		in progress	
18	a. How many control points need to be accounted for?		in progress	
19	b. How many window shade zones are there going to be?		in progress	
20	c. Will this be associated with daylight harvesting? If so, how?		in progress	
21	d. What is the sequence of operation associated with the window shade control?		in progress	

22	9. The documents state that their will be a networked elevator controls/monitoring system provided. Will this be an IP integration? If it is an IP integration aren't all IP integrations carried out by UK UEM and therefore the BAS contractor would not perform this portion of the scope of work?	CMTA	elevation integration shall be BACnet over IP.	
23	10. On page 237 of the RFP under 7. Scope Clarifications-Scope Specific: Item 68 mentions that the BAS contractor shall furnish and install all VAV Venturi valves, controls, 24 vac power, rpms, room humidity monitors, DAT sensors, etc.	CMTA	Venturi valves to be supplied by the BAS contractor installed by division 23. VAV boxes are not purchased or installed in this package. The rest of that list is to be provided and installed by BAS contractor as stated.	
24	a. Please confirm that the BAS contractor is responsible for furnishing the venturi valves.	CMTA	confirmed	
25	b. The BAS contractor should not be responsible for installing the venturi valves. Please confirm this is the responsibility of the mechanical contractor. This is also mentioned on item 69.	CMTA	This will be clarified. The BAS contractor should provide but not install the venturi valves.	
26	11. Is the BAS contractor also responsible for furnishing any reheat coils associated with the venturi valves?	CMTA	no, this is by division 23	
27	12. For the medical refrigerator/freezer monitoring. The sequence says that these medical refrigerators/freezers will be provided with an integral temperature sensing sweet.	CMTA	this will be clarified. The BAS contractor will need to provide a temp sensor capable of integrating into the BAS. Refrigerators and freezers will have a port through which the temp probe connects to.	
28	a. Is this an integration? If so, what is the communication protocol? BACnet MSTP?		in progress	
29	b. Is this just points to wire to the inputs and outputs of a controller?		in progress	
30	c. How many points are required per refrigerator/freezer?		in progress	
31	13. Note IC17 calls out the refrigerator/freezers. How do we indicate which refrigerator/freezer on the drawings is considered a "medical refrigerator/freezer" and which notes are referring to Walk-In cooler/freezers?	CMTA	They are tagged and labeled on the IC drawings	
32	14. Note IC29 mentions that the medical gas manifold scales are to be integrated and monitored by the BAS. Will this be a BACnet MSTP integration? Will this be a BACnet IP integration and if so, will UK UEM integrate this?		in progress	
33	15. Are the CRAC units going to be provided with MSTP controls for integration by the BAS contractor or BACnet IP controls to be integrated by UK UEM?	CMTA	Crac units will be provided with a factory mounted controller capable of integrating via BACnet over MSTP.	
34	16. Who is responsible for furnishing and installing the door switch associated with the air curtain controls?	CMTA	The door switch is to be provided by the air curtain manufacturer.	
35	17. Can you confirm if the BAS contractor is supposed to provide the ability to command the electric unit heaters? The sequence states for these units to operate under their own controls, but then later states that the DDC system shall have the capability to start and stop these units. The points list does not indicate command or status.	CMTA	this will be clarified. Points list will have a command and status.	
36	18. There are several points list that are titled AHU-9 points. Please clarify that these other points list have nothing to do with AHU 9. The Generator and Exhaust Fans.	CMTA	Correct, the AHU-9 designation is a typo. The points on the list are correct.	
37	19. The glycol water system controls points list is titled with baseboard heating water system. Please confirm this is a typo.	CMTA	confirmed typo	

38	20. Regarding the Fan Coil Units, will these be provided with (1) step down transformers to give power to the controller, (2) will the controls contractor have to provide a transformer, or (3) does power for the controller for the FCU's need to be provided independently of power provided to the FCU?	CMTA	fan coil units will be provided with a field mounted controller. Controls contractor shall be responsible for all low voltage power and wiring neccessary for controls integration.	
39	21. Who is responsible for 120V power to power supplies for low voltage power distribution to terminal unit controllers (VAVs and PHX valves)?	CMTA	These should all be low voltage and power supplied by BAS contractor	
40	22. Who is responsible for 120V power to BAS contractor control panels?	CMTA	There are some shown on the division 26 drawings and the division 26 contractor has those included in his scope. Any additional power needed for control panels is to be included by the BAS contractor.	
41	23. Is the BAS contractor responsible for furnishing smoke and combination fire/smoke dampers?	Walsh	no	
42	24. Is the BAS contractor responsible for providing power to smoke and combination fire/smoke dampers?	Walsh	no	
43	25. Is the BAS contractor responsible for controlling or monitoring status of smoke and combination fire/smoke dampers?	CMTA	monitoring only	
44	Please provide details as to what information is required for the 'Technical Proposal'.	Walsh	Refer to Section 4.0 of the RFP Proposal Format and Content for requirements for the Technical Proposal	
45	It is our assumption, from reading the RFP, that there are 3 separate envelopes to be submitted. (1) Financial Proposal - containing only 'Criteria 3 Financial Proposal', (1) Technical Proposal - pending confirmation of details (question No.1 submitted), and (1) RFP Response / Qualifications - containing the remaining sections: signed authentication of proposal and statement of non-collusion and non-conflict of interest form, transmittal letter, executive summary and proposal overview, criteria 1 offeror qualifications, criteria 2 services defined, criteria 4 evidence of successful performance and implementation schedule, criteria 5 other additional information. Please confirm.	Walsh	There should be 2 separate Submissions: Financial Proposal and Technical Proposal. All items that are not a direct response to Section 8.0 Financial Offer Summary, shall be included in the Technical Proposal.	
46	Note I26 on multiple drawings calls for the controls contractor to provide and install building lighting controls panel. But in the RFP and on IC210 there is mention of a "lighting control vendor". Would the lighting control vendor not provide the lighting control panel and the controls contractor just integrate to that panel? Is the lighting control panel not going to be integrated via BACnet IP? Aren't BACnet IP integrations handled directly by UK's controls group?	Walsh	Correct. The lighting controls will be bid under division 26 and BAS contractor will integrate these controls into the BAS	
47	In the bid form cost breakdown there is a line item for core and shell systems. What documents are we supposed to reference to delineate the core and shell from the fitout? Can a list of systems be provided for what is considered to be the core and shell?	Walsh	Core and shell systems are considered the major equipment located in dedicated mechanical or electrical rooms.	
Received by project team after RFI Deadline				

48	What is the fee associated with participating in the TEXTURA payment management system? Is this a flat dollar amount for contracts above a certain amount or a % of our entire contract?	Walsh	From Ex B.1 CM Unified General Conditions 8.8: Subcontractors are required to use Textura Payment Management System in accordance with Exhibit N for monthly pay applications. Subcontractor to reference Prompt Payment for Construction Contracts. Subcontractor includes in their Bid the Subcontractor Usage Fee which is equal to .22% of their contract value up to a maximum of $5,000	
49	Please clarify expectations and level of design as it relates to BIM for the Controls Bid Package		in progress	
50	Please confirm that the Controls Contractor is responsible for Design Assist Engineering		in progress	
51	Please confirm Pressure Reducing Valve will be provided by the Mechanical Contractor.		in progress	
52	Please provide mechanical schedules for VAVs.		in progress	
53	Please confirm VAV Boxes are included in Controls Contractor's Bid Package.	Walsh	VAV boxes are to be provided by Div 23 Contractor.	
54	Please provide Piping information for AHU Hot and Chilled water valves.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
55	Please provide Piping information for Humidifier control valves.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
56	Please provide Electrical Floor plan drawings.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
57	Please provide Plumbing Floor Plans drawings.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
58	Please clarify Note IC26 on IC-100. Please indicate whether the controls contractor is to furnish the lighting control panel.	Walsh	See previous answer above	
59	Please clarify Note IC27 on IC-100. Please indicate whether the controls contractor is to furnish the fire control panel.		in progress	
60	Please clarify Note IC20 on IC-100. Please indicate whether the controls contractor to install Boiler Control Panel.		in progress	
61	Please indicate which contractor is to furnish Fire/Smoke Dampers & Fire Dampers	Walsh	Dampers to be provided by Div 23 contractor	
62	Clarify which Contractor is responsible for furnishing Venturi Valves, Venturi Controls, and the Venturi Controls Wiring/Installation.	Walsh	Venturi valves to be furnished by Controls Contractor and installed by Div 23 Contractor. All controls and wiring by controls contractor.	
63	Please provide Floor area drawings locating Steam Pressure Reducing Valve System.			

64	Please provide Floor area drawings locating Lab Air Compressors.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
65	Please provide Floor area drawings locating Lab Emergency Showers.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
66	Please provide Floor area drawings locating Medical Vacuum Pump.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
67	Please provide Floor area drawings locating Gas meters.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
68	Please provide Floor area drawings locating Building Natural Gas meters.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
69	Please provide Floor area drawings Power meters.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
70	Please provide Floor area drawings locating Elevator Sump pumps.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
71	Please provide Floor area drawings locating Elevator Control system.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
72	Please provide Floor area drawings locating Fuel Oil pump.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
73	Please provide Floor area drawings locating Fire pump.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
74	Please provide Floor area drawings Domestic Water Booster pump.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
75	Please provide Floor area drawings Linear Accelerator Cooling control.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
76	Please provide Floor area drawings locating Fan Filter unit.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	

77	Please provide Floor area drawings locating Medical Gas and Medical Gas manifolds.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
78	Please provide Floor area drawings locating Refrigerators and Freezers.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
79	Please provide Floor area drawings locating Automatic Transfer Switch.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
80	Please provide Floor area drawings locating Parallel Switchgear.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
81	Please provide Floor area drawings locating 480V Switchgear.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
82	Please provide Floor area drawings locating Essential Electrical Switchgear.	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
83	Please provide Floor area drawings locating Emergency Generators	Walsh	Fit Out Interior Drawings have been provided for Reference with the original RFP documents. Core and Shell Documents to be made available, for coordination and reference, as part of an addendum.	
84	Please indicate which Contractor is responsible for 120V power to Control Panels	Walsh	Div 26 Subcontractor to provide 120V power.	
85	Please indicate which Contractor is responsible for 120V power to power supplies for low voltage power distribution to Terminal Unit Controllers	Walsh	Div 26 Subcontractor to provide 120V power.	
86	Please indicate which Contractor is responsible for network drops for Tier 1 Controllers	Walsh	Div 27 Subcontractor to provide data ports.	

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DIVISION 21 – FIRE SUPPRESSION

DIVISION 22 – PLUMBING

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

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SECTION 232923 – VARIABLE FREQUENCY MOTOR CONTROLS

PART 1 - SUMMARY

1.1 GENERAL

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IEEE: Institute of Electrical and Electronics Engineers

F. IGBT: Insulated-gate bipolar transistor.

G. LAN: Local area network.

H. LED: Light-emitting diode.

I. MCP: Motor-circuit protector.

J. NC: Normally closed.

K. NO: Normally open.

L. NRTL: National Recognized Testing Laboratory

M. OCPD: Overcurrent protective device.

N. PCC: Point of common coupling.

O. PID: Control action, proportional plus integral plus derivative.

P. PWM: Pulse-width modulated.

Q. RFI: Radio-frequency interference.

R. TDD: Total demand (harmonic current) distortion.

S. THD(V): Total harmonic distortion (voltage).

T. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Harmonic Analysis Study and Report: Comply with IEEE 519-2014 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels. VFD manufacturer shall provide all means of mitigation of harmonic contributions, including but not limited to, harmonic filters, in order to ensure that voltage and current distortion limits are within the required ranges as indicated in Tables 1 and 2 of IEEE-519-2014. Analysis shall indicate point of common coupling.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
   2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
   3. Humidity: Less than 95 percent (non-condensing).
   4. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner 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 five days in advance of proposed interruption of electrical systems.
   2. Indicate method of providing temporary electrical service.
   3. Do not proceed with interruption of electrical systems without Owner’s permission.
   4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
   1. Torque, speed, and horsepower requirements of the load.
   2. Ratings and characteristics of supply circuit and required control sequence.
   3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   1. ABB.
   2. Allen Bradley.
   3. Yaskawa Electric America, Inc; Drives Division.

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
   7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
   8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
   9. Humidity Rating: Less than 95 percent (non-condensing).
   10. Altitude Rating: Not exceeding 3300 feet.
   11. Vibration Withstand: Comply with IEC 60068-2-6.
   12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   14. Speed Regulation: Plus or minus 5 percent.
   15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.
   2. Signal: Pneumatic.

J. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   3. Under- and overvoltage trips.
   4. Inverter overcurrent trips.
   5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   6. Critical frequency rejection, with selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   8. Loss-of-phase protection.
   9. Reverse-phase protection.
   10. Short-circuit protection.
   11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA KS 1, non-fusible switch, with power fuse block and current-limiting fuses with pad-lockable, door-mounted handle mechanism.

   1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
   2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
   4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
   5. NC alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital displayand additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

E. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multi-drop LAN configuration; settings retained within VFC's nonvolatile memory.
   1. Network Communications Ports: Ethernet.
   2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet ; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: provide 3% input filtering, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.4 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1 .

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

C. Where redundant VFD's are specified, the redundant VFD's and all associated equipment shall reside in a single enclosure.

2.5 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, type.
      a. Push Buttons: Unguarded types; maintained.
      b. Pilot Lights: LED types; ; push to test.
      c. Selector Switches: Rotary type.
      d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Fusible Disconnect Switch interlock: provide interlock such that when disconnect switch is open, VFD stops sending power to load.

D. 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.
   1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 519-2014 and NETA Acceptance Testing Specification.

C. Provide all necessary appurtenances to mitigate harmonic distortion of building electrical system.

3.3 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs 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 on walls, provide freestanding racks.

C. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base.
   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 supported equipment.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 232400 "Identification, Tags, Charts, Etc."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables." All control wiring shall be in separate conduit from power wiring.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control 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.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. 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 amperes and attempt to start motors several times, allowing for motor cool-down 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 Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 232923

SECTION 250200 – INSTRUMENTATION AND CONTROL FOR HVAC – UK STANDARDS

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and General Requirements, Division 1 Specification Sections apply to the work specified in this section.

DESCRIPTION OF WORK:

Furnish a BACnet system compatible with existing University systems. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet. This system shall communicate with the University of Kentucky Facility Management's existing BACnet head-end software using BACnet/IP at the tier 1 level and BACnet/MSTP at the tier 2 level. No gateways shall be used for communication to controllers installed under section. BACnet/MSTP or BACnet/IP shall be used for all other tiers of communication. No servers shall be used for communication to controllers installed under this section. If servers are required, all hardware and operating systems must be approved by the Facilities Management Controls Engineering Manager and/or the Facilities Management Information Technology Manager.

All Building Automation Devices should be located behind the University firewall, but outside of the Medical Center Firewall and on the environmental VLAN.

Provide all necessary hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers. These must be in compliance with Front End systems PICS and BIBBS and attached Tridium PICS and BIBBS. Provide all hardware and software to backup, restore, troubleshoot and install system. Software, backups, unitary, and ASC files shall be delivered to UEM (Utilities & Energy Management) for archiving purposes.

When providing a JACE or equivalent tier-1 controller, the licenses for ALL available points must be purchased by the installing contractor. It will not be acceptable for an installing contractor to install a JACE in a manner in which only part of the licenses for the available capacity have been purchased. Any contractor who is required to utilize an existing JACE to accomplish his final Tie-in to Tridium, must include the cost to accommodate his additional points BOTH at the local JACE level as well as the head-end Tridium level.

Prepare individual hardware layouts, interconnection drawings and software configuration from project design data.

Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

Provide a comprehensive operator, administrator and technician training program as described herein.

Provide as-built documentation, programming software for use site wide, electronic copies of all diagrams, and all other associated project operational documentation (such as technical manuals on approved media, the sum total of which accurately represents the final system.

Furnish, install, and fit-up in complete working order, with all accessories required, the automatic temperature control and monitoring systems shown on the Drawings and specified herein. The systems shall be properly connected, piped and wired in a manner conforming to the laws, ordinances and codes now in force in the Commonwealth of Kentucky.

The controls and all listed I/O points from this project shall communicate with the University of Kentucky Facilities Management's existing BACnet software head-end station using BACnet/IP. All BACnet points shall be exposed to the University of Kentucky Facilities Management's head-end station. Graphics will be installed by UEM on the head-end system. All point and device names shall comply with the University Facilities Management standards and shall be approved before and included in the shop drawings submittal. Cooperate with the Owner (UEM) to ensure that all specified points and alarms communicate and operate on the head-end system. All point and device names shall comply with the University Facilities Management standards (format listed below, consult Utilities and Energy Management (UEM) for the correct abbreviations) and shall be included in the shop drawings submittal for review and approval. Point naming conventions and formats are listed further in this specification in the Direct Digital Controls Equipment section. Refer to University Standard 230553S02 for the AHU Naming Convention.

Related to the alarms, the contractor is to set up the alarm parameters specified by the system sequences of operations without enabling the alarms. Contractor is to provide a list of points containing alarm extensions to Owner (UEM). UEM will be responsible for doing the alarm names, alarm texts and enabling the alarm points provided on the list.

All work must be coordinated and scheduled with the UEM Controls group prior to any work being done on site.

Thermostats: Each terminal unit requires a thermostat for operation, unless specifically indicated on the Drawings to be slaved to another unit. Slaved terminal units shall be controlled to match the CFM and discharge air temperature of the master unit. Thermostat locations have been identified on the Drawings to the extent possible, but all such locations may not be shown. Provide the required thermostats whether or not shown on the Drawings. For those thermostats not shown on the Drawings, work out an acceptable location with the Architect/Engineer. Thermostats are to be provided with no doors.

Provide DDC controls for the air terminal units. Provide electronic operators controlled and monitored by direct digital control systems which shall include, but not be limited to, air handling systems, pumps, terminal units, etc.

The control equipment shall be complete and shall include, but not be limited to, all necessary valves, damper operators, pipe, fittings, etc.

Electronic Control System installer must physically demonstrate to Owner and Owner's representatives (UEM) via software simulations that the proposed building automation system and control sequences will function as outlined in the contract documents prior to field implementation.

Provide VFD's as specified in other sections.

The control and monitoring system for this project shall be made up using standard materials, equipment and components regularly manufactured for systems of this type. The system shall be complete in every respect and shall be a functioning system.

Electrical power wiring and interlock wiring for all controls, signal devices, equipment, alarms, etc., shall be in accordance with diagrams and instructions from the supplier of the systems. All power and control wiring, conduit and wiring connections required for the complete installation, including wiring to smoke dampers and combination fire/smoke dampers and their motors, shall be provided by this Contractor in accordance with Electrical specification requirements. Controls shall be on emergency power.

Refer to other Mechanical Division sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.

QUALITY ASSURANCE:

Manufacturer: Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 1 BACnet/IP include the following:

Vykon Jace 8000
Johnson Controls Facility Explorer line of Niagara Powered Products
Alerton
Honeywell CIPer IP Series
Phoenix PCI Jace (for laboratory controls only)

Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 2 BACnet/MSTP include the following:

Honeywell WEB Series
Johnson Controls Extended Architecture Line
Alerton
Distech ECB

Acceptable controls manufacturers shall include any controls manufacturers which utilize a BACnet protocol in accordance with the specification. If the bidding manufacturer is not listed above, documentation for approval as an equal must be submitted 10 days prior to the bid opening date to allow for evaluation by the university.

Installing Contractor: Installing controls contractors must comply with the following requirements:

The installing systems integration contractor has been in the business of installing BACnet controls for the last 5 years minimum. In addition, the installing systems integration contractor needs to demonstrate with documentation that they have provided the controls in a minimum of (3) hospital or university renovation projects of similar size and scope where they utilized a BACnet system.

The systems integration contractor must have on staff the following number of key personnel as a minimum, each with a minimum of 5 years of related BACnet controls installation experience: Project Manager - 2, Controls Applications Engineer - 2, Programmer - 2, Installation Supervisor - 2, Controls Technician - 5.

Prefer contractor staff to include Niagara Tridium AX/N4 certified technicians.

Contractor to have experience with successful integrations of controls with Niagara Tridium systems.

Contractor to have a minimum of 3 years of installation history with the brand of controls being bid.

Contractor must have a help desk operation or staff available for phone contact 24/7 for providing technical

support to university staff. Call forward and emergency service numbers are not acceptable during normal business hours.

Codes and Standards:

Electrical Standards: Provide electrical components of pneumatic control systems which have been UL-listed and labeled, and comply with NEMA standards.

NFPA Compliance: Comply with NFPA 90A "Standard for the installation of Air Conditioning and Ventilating Systems" where applicable for controls and control sequences.

Kentucky Building Code: Comply with requirements where applicable for controls.

Provide products of the temperature control system with the following agency approvals:

UL-916; Energy Management Systems
UL-873; Temperature Indication and Regulating Equipment
UL-864; Subcategories UUKL, OUXX, UDTZ; Fire Signaling and Smoke Control Systems
CSA; Canadian Standards Association
FCC, Part 15, Subpart J., Class A Computing Devices

All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, NEC, Local and National Codes.

SUBMITTALS:

Product Data: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes, also include installation and start-up instructions.

A. Shop Drawings, Product Data, and Samples

1. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; BAS Contractor name, address and phone number; BAS Contractor project manager, quality control manager, and project engineer names and phone numbers.
2. Each submittal shall include the following information.
    a. BAS riser diagram showing all DDC controllers, network repeaters, and network wiring.
    b. One-line schematics and system flow diagrams showing the location of all control devices.
    c. Points list for each DDC controller, including: Tag, Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number. The initial shop drawing submittal for review needs to include all point names meeting the naming convention outlined in this specification for UEM approval at the shop drawing phase prior to the contractor beginning any programming.
    d. Vendor’s own written description for each sequence of operations, to include the following:

- Sequences shall reference input/output and software parameters by name and description.
- The sequences of operations provided in the submittal by the BAS Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
- Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.
- The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.

e. Detailed Bill of Material list for each panel, identifying: quantity, part number, description, and associated options.

f. Control Damper Schedules. This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.

g. Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calc CV, Design Pressure, Actual Pressure, and Actuator Type.

h. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, and so forth.

i. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.

j. Hardware data sheets for all local access panels.

k. Software manuals for all applications programs to be provided as a part of the programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.

l. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for each device.

3. BAS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

4. Submittal shall have approved point names.

Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, product and shop drawings in maintenance manual.

Operation and Maintenance Instructions:

This contractor shall prepare an electronic Operations Manual entitled "Automatic Temperature Control and Monitoring Systems Operation and Maintenance Data." Manual shall be PDF files with separate PDFs for each of the items noted below.

Each manual shall contain the following information:

Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

Complete brochures, descriptive data and parts list, etc., on each piece of equipment, including all approved shop drawings.

Complete maintenance and operating instructions, prepared by the manufacturer, on each major piece of equipment, including preventative maintenance instructions.

Complete shop drawing submittal on temperature and monitoring controls including control diagrams updated to reflect "as-built" conditions.

All wiring and component schematics necessary for Owner (UEM) to troubleshoot, repair and expand the system.

All manuals shall be submitted to the Engineer prior to final inspection of the building.

Provide a laminated copy mounted in a sleeve on the outside of the panels for the controls sequences pertinent to equipment supplied by that specific controls panel.

Controls Program Backup: At the end of the project, the contractor is to supply digital back-up copies of all final complete operating controls programs. These shall be delivered to UEM for archiving purposes.

DELIVERY, STORAGE AND HANDLING:

Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

PART 2 - PRODUCTS

DIRECT DIGITAL CONTROL SYSTEM

General: This specification defines the minimum hardware and performance requirements for a computer-based building automation system to be furnished and installed.

SCOPE OF WORK:

System Requirements:

Contractor shall provide all equipment, engineering and technical specialist time to check the installation required for a complete and functioning system. The contractor shall furnish and install all interconnecting system components. Components to include, but not be limited to: power line conditioners, field panels, sensors, motor starter interfaces, and any other hardware items not mentioned above but required to provide the Owner with a complete workable system.

Any feature or item necessary for complete operation, trouble-shooting, and maintenance of the system in accordance with the requirements of this specification shall be incorporated, even though that feature or item may not be specifically described herein. This shall include hardware and software.

All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall be thoroughly tested and proven in actual use.

Input/Output Summary:

The system as specified shall monitor, control and calculate all of the points and functions as listed in the Input/Output Summary.

System Start-Up and Acceptance:

Upon completion of the installation, the BAS Contractor shall start-up the system and perform all necessary testing and debugging operations. An acceptance test in the presence of the Owner's representative shall be performed. The vendor shall check all sensors that exhibit any problems or faulty reading. When the system performance is deemed satisfactory in whole by UEM, the system parts will be accepted for beneficial use and placed under warranty. The BAS Contractor is to be available for system commissioning at the end of the installation when requested by the Engineer and/or Owner. The contractor is to also be available for seasonal commissioning for the other seasons beyond the initial commissioning.

This Contractor shall work with the Owner (UEM), who is developing the graphics, to ensure that all points report, function and alarm as required on the BACnet head-end system. The Contractor will also work with the Project Manager or CNS/MCIS to obtain all necessary IP’s and Ethernet drops needed for BACnet panel. The Owner (UEM) will assign all BACnet/IP instance numbers and all BACnet/MSTP network numbers for use by the Contractor. All BACnet/IP devices will report directly to the head-end system.

UEM will be performing their own complete point by point evaluation as part of this project, independently of the commissioning activity. This will occur during the warranty period of the project.

Facilities Management’s Instruction:

The BAS Contractor shall provide two copies of an electronic version of the operator's manual describing all operating and routine procedures to be used with the system. This user's manual should contain subjects such as: standard operation, error message explanations, software usage, commands, system troubleshooting, etc. The Contractor shall also provide wiring schematics for all system components.

The BAS Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than four (4) hours during two 2 hour sessions. (Number of hours may be adjusted to a max of 40 dependent upon the size and scope of project. For larger projects, training vouchers for instructional training at the manufacturer’s facilities may be requested in lieu of on-site training.) These instructions are to be conducted during normal working hours at the Owner's convenience and are to be prearranged with the Owner. The owner can request this training any time within the one year warranty period and may request any number of classes adding up to the total number of hours. The contractor shall provide an hourly unit price for additional on-site training.

The instructions shall consist of both hands-on at the job site and classroom training at a classroom location on the University of Kentucky campus coordinated with the Project Manager and UEM.

Upon completion, the attendees shall be able to operate the system and implement system changes including start-up, boot load, add point to the data base, enter messages, and down line load field units.

Prior to the scheduling of the sessions, an agenda outlining the training topics must be submitted for approval. Agenda items shall include, but not be limited to, the following topics:

1) Explanation of control sequences. Include which sensors are used and how output device operates.
2) Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
3) Walk-through of project to identify controller locations and general routing of network cabling.
4) Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.
5) Programming Application Specific Controllers
   (a) Backing up and Restoring Application Specific Programming
   (b) Adding/Deleting/Editing points on Application Specific controllers
   (c) Troubleshooting Application Specific controllers (inputs/outputs/logic/master – slave relationships/bus issues)
6) Programming Building Specific Controllers
   (a) Backing up and Restoring Building Specific Controllers Programming
   (b) Adding/Deleting/Editing points on Building Specific Controllers controllers
   (c) Troubleshooting Building Specific Controllers controllers (inputs/outputs/logic/network issues)
7) How to use tools and cables

Warranty:

The system including all hardware and software components shall be warranted for a period of one year when the system performance is deemed satisfactory in whole by UEM. The system parts will be accepted for beneficial use and placed under warranty at that time. A Certificate of Occupancy does not initiate the control system warranty. Any defects in materials and workmanship arising during this warranty period shall be corrected without cost to the Owner.

All applicable software as detailed in this specification shall be updated by the BAS Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the BAS Contractor.

DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

System Software

All software required for monitoring, modifying, configuring and backup for the system shall be embedded in the controller and accessible via VT terminal, hyper-terminal or the web. This software shall allow any computer with access (and security) to the University's network to perform the work described above using a web browser or provided software. No software upgrades should be required unless provided at no additional cost to the customer. The software version used for installation of any new devices must either be at the current software version used on the University Facilities Management campus at the current JAVA version or the new software at the most current JAVA version must be installed on all devices and the current system prior to the installation of the new devices. All software is to also operate on the latest version of Microsoft Windows operating system. All configuration and programming tools required for the upgraded version must be provided at the time of installation.

Provide a USB, standard RS-232 9 pin female, Bluetooth, RJ11, RJ12 or RJ45 connection for on-site access.

BACnet Conformance

Building Controller shall as a minimum support MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:

1. Clock Functional Group
2. Files Functional Group
3. Reinitialize Functional Group
4. Device Communications Functional Group
5. Event Initiation Functional Group

Please refer to end of this section for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data.

Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. Alarms should also be setup on this system with limits. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data.

The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork. It must support interoperability on the campus area network and function as a BACnet Broadcast Management Device (BBMD) and/or a BACnet router.

Building Controller (B-BC)

General

Building Controller (B-BC) shall be minimum 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system.

The B-BC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board B-BC controller database shall be performed on-line using the built-in software. Systems which require the B-BC to be removed from service while DDC control sequences are modified shall not be acceptable.

B-BC controllers shall utilize true floating point arithmetic capabilities.

All B-BC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.

Databases and Memory Back-Up

All programming defining the functions to be performed by the B-BC, including but not limited to application programs and point database within each B-BC, shall be protected from loss due to power failure for a minimum of 72 hours. All database and backup shall be provided to the UK UEM Controls group.

Service Ports

B-BC controllers shall be equipped with a minimum of one operator service port for the connection of a laptop computer. The service port shall be either a built-in standard RS-232 data terminal port, USB port, CAT5 cable or RJ11/12 connection.

Connection of a service device, to a service port, shall not cause the B-BC controller to lose communications with its peers or other networked device controllers.

Display and Readout Capability

The B-BC controller shall additionally provide diagnostic LED indication of device transmit and receive data communications for all communication port and peripheral ports, normal operation, abnormal operation and control relay operation indication.

Manual/Auto Control and Notification

The B-BC controller shall provide commanded override capability from the built-in operator interface. Such overrides shall be annunciated to the head-end station. Such overrides shall be valid as long as power is applied to the controller.

Adjustments

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual B-BC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the B-BC. From a single B-BC user interface, any other B-BC shall be accessible and full adjustment capabilities shall be provided.

B-BC Naming Convention

B-BC devices shall be named using the following naming convention:

> *B-BC devices shall be named using the following format:*
> *BuildingName_BuildingNumber_Floor_RoomNumber_B-BC Device Type* OR
> *BuidlingNumber_BuildingName_Floor_RoomNumber_B-BC Device Type*
>
> *All B-AAC points shall be named using the following format:*
> *Building_Floor_RoomNumber_Device Type_Equipment ShortName_Function*

Examples:

A B-BC device located in the Pavilion HA mechanical room HA4001 would be named as follows:

PAVHA_0293_04_HA4001_JACE

An exhaust fan status point for a fan in Pavilion HA mechanical room HA3001 fed directly from the above

panel would be named as follows:

PAVHA_03_HA3001_HVA_EF1_STAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

Advanced Application Controller (B-AAC)

General

Controls shall be microprocessor based, Advanced Application Controllers (B-AAC's). B-AAC's shall be provided for Air Handling Units, packaged Rooftops, primary and secondary pumping loop systems and other applications as shown on the drawings. B-AAC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-AAC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the owner. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.

All B-AAC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.

Contractor shall provide a minimum of one B-AAC controller per air handling or mechanical system as shown on the drawings.

The BAS contractor shall provide and field install all B-AAC's specified under this section. Mechanical equipment manufacturers desiring to provide B-AAC' type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

All input/output signals shall be directly hardwired to the B-AAC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

B-AAC's shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The B-AAC's shall communicate with the B-BC at a minimum baud rate of 9,600 baud.

Non-Volatile Memory

All control sequences programmed into the B-BC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-BC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table are not acceptable.

All control sequences shall be fully programmable at the B-AAC, allowing for the creation and editing of an application control sequence, while at the unit.

The B-AAC shall be provided with an interface port (standard RS232 data terminal port or USB port) for a laptop computer. The interface port shall allow the laptop to have full functionality as described above. From the interface port or *network terminal, the laptop shall be able to directly access any B-AAC or B-ASC in the* network.

The B-AAC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days.

Systems unable to provide the above capability shall provide for the individual Input/Output point trending at the B-BC. Specifics as to how each B-AAC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-AAC's per B-BC that can be expected.

The B-AAC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

The B-AAC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the B-AAC, without loss of setting. The battery for the time clock shall be replaceable by the customer. The B-AAC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.

Controller Location

To simplify controls and mechanical service troubleshooting, the B-AAC shall be capable of being mounted directly in or on the controls compartment of the air handling system. The B-AAC shall be housed in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The B-AAC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The B-AAC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

Every controller and control panel shall be labeled with a lamacoid plate permanently secured to the device. Sticky tape or glued labels are not acceptable. The labeling shall describe the device and include related information such as MAC address, IP address, BACnet Instance numbers, etc.

All power feeds shall be clearly identified and shall include panel number, breaker and electrical panel location if not in the same room.

For compatibility to the environment of the air handling unit, B-AAC's shall have wide ambient ratings. B-AAC's shall be rated for service from -40 DegF (Degrees Fahrenheit) to 140 DegF.

Contractor shall submit description of location of B-AAC's on all mechanical and air handling equipment.

B-AAC Naming Convention

B-AAC devices shall be named using the following naming convention:

B-AAC devices shall be named using the following format:
Building_Floor_RoomNumber_B-AAC Device Type_Equipment Short Name

All B-AAC points shall be named using the following format:

Function

Examples:

An Air Handler controller in the Pavilion HA mechanical room HA4001 for AHU7 would be named as follows:

PAVHA_04_HA4001_HVA_AHU7

The mixed air temperature point for the above system would be named as follows:

MAT

Therefore, when this point is learned, the entire point name will be:

PAVHA_04_HA4001_HVA_AHU7_MAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

Application Specific Controller (B-ASC)

General

Controls shall be microprocessor based Application Specific Controller (B-ASC). B-ASC's shall be provided for Unit Ventilators, Fan Coils, Heat Pumps and other applications as shown on the drawings. B-ASC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-ASC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.

Contractor shall provide a minimum of one B-ASC controller per unitary system as shown on the drawings.

The BAS contractor shall provide and install all B-ASC's specified under this section.

All input/output signals shall be directly hardwired to the B-ASC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

B-ASC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The B-ASC's shall communicate with the B-BC at a baud rate of no less than 38,400 baud.

Non-Volatile Memory

All control sequences programmed into the B-ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the B-ASC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-ASC shall allow for the creation of unique application control sequences.

The B-ASC shall be provided with the ability to interface with a laptop computer. The interface port shall be provided at the wall sensor or within the unitary equipment. Connection to the wall sensor must be a standard RJ-45 or USB port.

The B-ASC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken.

Systems unable to provide the above capability shall provide for the individual input/output point trending at the B-BC. Specifics as to how each B-ASC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-ASC's per B-BC that can be expected.

Controller Location

To simplify controls and mechanical service troubleshooting, the B-ASC shall be mounted directly in the controls compartment of the unitary system. The B-ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The B-ASC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

For compatibility to the environment of the unitary equipment, B-ASC shall have wide ambient ratings. B-ASC's shall be rated for service from 32 DegF (Degrees Fahrenheit) to 140 DegF.

Contractor shall submit description of location of B-ASC's on all mechanical and unitary equipment.

B-ASC Naming Convention

B-ASC devices shall be named using the following naming convention:

B-ASC devices shall be named using the following format:
Building_Floor_RoomNumber_B-ASC Device Type

All B-ASC points shall be named using the following format:
Function

Examples:

A VAV controller in the Pavilion HA room HA498 would be named as follows:

PAVHA_04_HA498_VAV

The discharge air temperature point for the above room would be named as follows:

DAT

Therefore, when this point is learned, the entire point name will be:

PAVHA_04_HA498_VAV_DAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

CONTROL PANELS

Panelboard shall contain all instruments and accessories. Provide each item of equipment with an engraved nameplate. Panelboard shall be wall-mounted or stand-mounted and shall be completely enclosed.

As far as is practical, the control components for each system shall be grouped. Provide each group of components with identification.

The entire panelboard shall be pre-wired and brought to a main terminal strip. All relays, switches, etc., shall be installed, furnished and wired on panelboard. Clearly mark each terminal strip as to which wire from which component is to be connected.

Fabricate panels of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.

Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.

Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.

Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

SENSORS

Electronic Sensors used in air ducts or liquid lines shall utilize non-adjustable RTD or thermostat sensing elements with + or -0.36^{o}F, accuracy and stability of at least + or -0.05^{o}F per year. All sensors used in liquid line shall be provided with separable stainless steel immersion wells. Averaging sensors shall be a minimum of five (5) feet in length, and shall be installed in such a manner so as to sense representative sample of the medium being controlled.

Equipment Operation Sensors: As follows:

Status Inputs for Fans: Differential-pressure switch with adjustable range set to 175 percent of rated fan static pressure. A hawkeye sensor should also be provided so that the owner knows if belts are lost or fans are running backwards.

Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs (preference is 4-20mA or 0-10 Volts), or continuous proportional current or voltage to 0 to 20 psi (0 to 138 kPa).

Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent damper travel.

SENSOR INPUT AND OUTPUT DEVICES:

The following sensors and devices, or their equivalents, shall be considered acceptable. Other sensors and devices required for this specification are outlined in their respective subsystem.

Analog sensing elements for remote indication shall be independent of local pneumatic sensors used for local control loops.

System Accuracy: The system shall maintain an end-to-end accuracy for one year from sensor to operator's console display for the application specified.

STANDARD	Temperature Sensors
TYPE	Electronic
APPLICATION	BAS, HVAC, BTU, Boiler Control
STANDARD	100 or 1000 ohm platinum wire wound RTD element Standard J (3 wire) configuration European curve, Alpha = .00385 Ohms/Ohm/deg.C., meets DIN SID 43760 Wire in conduit
MECHANICAL	1/4" stainless steel sheath
SPACE TEMPERATURE	Sensor housing to be similar in appearance to existing thermostats except that thermometers are not required. Similarity to be Owner's decision. Locate on an outside wall if possible.
DUCT TEMPERATURE	Standard lengths -- 5.5", 11.5" and 17.5" Other lengths with owner's written approval. Locate in central area of airstream at minimum of 18" from reheat coil. 1/2" NPT mounting thread and flange and conduit connection. Glass encapsulated element unless otherwise approved.
THERMOWELL	Drilled brass or stainless steel or brass fitting with stainless steel sheath built-up well with Owner approval. Glass encapsulated element unless otherwise approved. 3/4" process connection with drilled wells. 1/2" NPT process connection on built-up wells. Insertion into measured medium - 1" + 1/2" diameter of pipe. Cast iron connector head - 1/2" NPT process connection and conduit connection. Rated thermowell pressure = 250 psi.

ELEMENT ACCURACY must meet .1% DIN and the DIN 43760 standard.

OVERALL ACCURACY	+ 1 deg.F. General duct, space and thermowell temperatures. + .75 deg.F. for thermowell ele. on 4" or larger pipes. + .5 deg.F. for thermowell ele. on 8" or larger pipes.

OVERALL RANGE -20% to l20% of possible operating conditions.

GENERAL NOTE If wires from RTD probe to DGP are to be more than 200 feet long, provide extra large cast iron connector head (nominal size 2-11/16 x 1/4) or junction box to accommodate a resistance to 4-20 mA convertor transmitter.

STANDARD Pressure Sensor

TYPE Electronic with LVDT element.

APPLICATION
4-20 mA Output (2 wire)
Wire in conduit
Input voltage 10-35 volts DC
Loop resistance greater than or equal to 500 ohms

MECHANICAL
Linear variable differential transformer (LVDT) element
Allowable Standard Ranges 0- 30 PSI
0-100 PSI
0-200 PSI
Other ranges with Owner written approval
1/2" NPT input thread and conduit connection.
Provide differential inputs unless otherwise approved.
Provide an air filter on unused differential ports.
Provide with a NEMA 4 watertight enclosure unless otherwise approved.
Min. rate pressure - l50% FS proof and 450 PSI static.

OVERALL ACCURACY + 0.5% F.S. including Linearity, hysteresis and repeatability.

ACCURACY NOTE: If pressure transducer is used to calculate flow with a pilot tube, then the accuracy of the pressure sensor should be dictated by the overall accuracy requirement of the system and would probably require a high accuracy sensor.

This section covers all new transducers provided. All new transducers provided shall be of the following type:

	INPUT	OUTPUT
l.	Temperature (deg.F.)	4-20 mA, 2 wire
	Temperature (deg.F.)	100 ohm platinum wire RTD
2.	Pressure	4-20 mA, 2 wire
3.	Flow Instantaneous	4-20 mA, 2 wire
4.	Flow Integrated	Pulse 10 PPS Max A25 msec open (min.) 40 msec closed (min.)
5.	KW Instantaneous	4-20 mA, 2 wire
6.	KWH - Integrated	Pulse – 10 PPS Max A25 msec open (min.) 40 msec

closed (min.)

Digital inputs from devices with isolated, dry type contacts (no grounds, no voltage) of either normally open (N.O.) or normally closed (N.C.) configuration. Live contact inputs, those that have voltage present, shall be provided with isolating devices to meet dry contact requirement.

THERMOSTATS:

Room Thermostats: Provide room thermostats that work in conjunction with the B-AAC and B-ASC terminal unit controllers. Thermostats shall have visible thermometers, setpoint indication and exposed setpoint adjustment in all areas except public spaces. Thermostats are to have push buttons on the front face for adjusting the temperature setpoints. Thermostats are to have no doors.

In cases where a single room sensor is to be shared by multiple controllers the slave box reheat control valves and dampers shall be individually controlled to track the discharge temperature of the master unit. The Master shall be identified locally and on the FMS.

An RJ-11 type connection to serial port shall allow a local portable operator or programmer’s terminal to access all program blocks and attributes for complete programmability.

Room Thermostat Accessories: As follows:

Insulating Bases: For all thermostat installations.

Thermostat Guards: Locking transparent-plastic mounted on separate base.

Adjusting Key: As required for device.

Aspirating Boxes: Where indicated for thermostats requiring flush installation.

DAMPERS:

Provide automatic control dampers as indicated, with damper frames not less than 13-gage galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-gage galvanized steel, with maximum blade width of 8".

Secure blades to 1/2" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.

Do not exceed maximum 48"x48" damper size. For sizes larger then this maximum in either dimension, use multiple dampers with a separate operator for each damper. Do not link separate dampers together.

Operating Temperature Range: From -20 degrees to 200 degrees F. (-29 degrees to 93 degrees C.). The occupant shall have an operation local range of 68 degrees and 74 degrees on rooms with Occupancy sensors.

For standard applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable steel blade edging, or replaceable rubber seals, rated for leakage less than 10 CFM/sq.ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

Smoke Dampers: Provide smoke and combination fire/smoke dampers in accordance with applicable requirements of Specification Section "Ductwork Accessories".

ACTUATORS:

Electric Valve and Damper Motors: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified.

For chilled water and preheat heating water coils at all air handling units, provide Belimo Energy Valves (or equivalent). Energy Valve shall have BACNet/MSTP interface for integration into controls system. Integrate all available control points to the BAS.

For reheat coils in branch ductwork and heating coils for air terminal units and fan terminal units, provide pressure-independent characterized control valves (PICCV) with non-spring return, fully proportional, floating valve actuators.

For all other applications, provide permanent split-capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, with integral spiral-spring mechanism. Furnish entire spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

Equip motors for outdoor locations and for outside air intakes with "O ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at -40 degrees F. (-40 degrees C.)

Provide separate motor for each outside air, return air and exhaust air damper. Do not link dampers with different functions together on one damper motor.

Provide separate motor for each damper when overall damper size exceeds 48" in either dimension. Do not link different dampers together on one damper motor.

Binary backed-up motors are not acceptable.

MISCELLANEOUS:

Wells for Pipe Mounted Sensor: Wells shall have minimum working pressure of 150 WOG psig. Wells shall be brass or stainless steel.

Lightning Protection: All electric/electronic equipment supplied must be internally or externally lightning/transient surge voltage protected on all external power feeder and input/output connections which are subject to surge voltage transients. Provide high speed clamping elements which meet IEEE. STD. 472 (SWC) on all digital or analog date channels.

Pressure Instruments:

Differential Pressure and Pressure Sensors: Sensors shall have 4-20 mA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging device. Accuracy shall be within 2% of full scale.

Pressure Switches: Pressure switches shall have repetitive accuracy of +2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over operating pressure range. Switch shall have application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy or gold plating.

Current Sensing Relays: Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for application. Setpoint of contact operation shall be field adjustable.

Low Voltage Wiring: Control wiring for analog functions shall be 18 AWG minimum with 600 volt insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

Low Voltage Wiring: Wiring for electric or electronic circuits less than 25 volts shall be cabling manufactured for express use in air plenums. The plenum cable shall be 24 gauge or larger as required, tinned copper, Teflon insulated, twisted pairs, shielded or unshielded, as required, a color coded, overall tape wrap, with transparent Teflon jacket, 150V., NEC725, Class 2 classified for use in air plenum non-conduit signaling application.

Manual Override Switches: In case of failure of the DDC system, provide override switches to operate fans, pumps, air handling units, cooling tower, heat exchangers, etc., manually in local interface control panel. Also for temperature and pressure control provide switches to allow supply temperatures, water temperatures, supply air pressure and fans to be manually regulated. All switches shall be located in locked panel to prevent unauthorized use of the manual override switches.

PART 3 - EXECUTION

INSPECTION:

Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

INSTALLATION OF AUTOMATIC TEMPERATURE CONTROLS

General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on the Drawings.

CONTROL WIRING:

Contact the project manager for all required Ethernet connections for this project.

Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code. Install wiring in electrical conduit in all areas. All controls conduit shall be green in color.

Conceal conduit, except in mechanical rooms and areas where other conduit and piping are exposed.

Install all control wiring with color-coded wire in ¾” minimum size conduit. Wire gauge to be in accordance with National Electrical Code.

Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

POWER WIRING:

Provide power wiring and conduit to air terminal units (if required) and to smoke dampers and combination fire/smoke dampers and their damper motors.

Furnish and install power cabling and conduit for temperature controls panels and equipment from emergency power panels. Each temperature control panel shall be connected to a separate circuit. Conduits shall connect to panels at the locations directed by the Contractor under Division 26. Final connection in the power panels shall be by Temperature Control Contractor in coordination with Division 26 Contractor.

MISCELLANEOUS:

Software Programming: All software programs shall be programmed by this Contractor.

Installation of Mechanical Devices: Refer to Mechanical Division sections for installation of valve bodies, control wells and dampers; not work of this section.

ADJUSTMENT AND SERVICE:

After completion of the installation, the automatic temperature control manufacturer shall regulate and adjust all thermostats, control valves, motors, and other equipment provided under his contract and shall place them in complete operating condition, subject to approval by the Engineer and Owner.

This shall include but not be limited to “tuning” of all control systems. Systems shall be tuned for decaying wave response and minimal overshoot of setpoint. Contractor is to not leave any system in an Auto Tune mode.

Room temperature controls shall have one temperature setpoint with less than a 0.5˚F between calculated heating and cooling temperatures.

This Contractor shall work with Balancing Contractor to provide verification of CFM reading from the DDC terminal unit controllers.

Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

After completion of installation, perform the following:

Installation.

Check proper installation and connection of each control device.
Verify electric power.
Verify each sensor and actuator connection to field computer.

Field Computer Operation.

Point Test.
- check of wiring of each sensor and actuator end-to-end
- verify calibration of each sensor.
- verify manual operation of each actuator.

Local loop control.
- bring each local loop under control.
- check response to upset, change in setpoint.
- check full and partial load operation.

Supervisory functions.
- verify time clock schedules.
- verify reset control.

Verify communication with each field device.

- perform end-to-end sensor and actuator checks.
- verify that the database is correct.

Test other software.
Trend Logging.
Report Generation.
Remote Access.
System Documentation.

Verify proper operation of every control point in the presence of the Engineer. Include point-by-point checkout.

The control manufacturer shall provide a period of free service extending through one complete heating season and one complete cooling season, after acceptance of the control system, and shall report the condition of the control equipment to the Owner and the Architect.

PART 4 - SEQUENCE OF OPERATION:

(The consultant is responsible for providing the appropriate Sequences of Operation required by the project. Following are some guidelines for use in the development of the drawings and specifications as they relate to University projects.)

AIR HANDLING UNITS (AHU)

For all AHUs, the following is a minimum points list that is required for each unit:
Supply discharge temperature
Return temperature
Mixed Air temperature
Preheat temperature
OA temperature
Damper positions – OA, RA, MA
Pressures – Discharge Static, 2/3 Static, Return Static
Fan Commands & Statuses of all fans – Supply, Return and Exhaust
Heating & Cooling Coil Valve Commands
All VFD information – Fans and Pumps
Pump Commands and Status
CFM readings – Discharge, Return, Outside Air
Humidifier Commands and Humidity points
Setpoints for temperature and pressures
Filter pressure differentials

Related to freezestat operation for all AHUs, the following sequence needs to be added to each sequence: *Upon tripping of the freezestat, the heating control valve is to modulate to maintain a heating plenum space temperature of 3 degrees F (adj) less than the specific unit DAT setpoint. Example: For unit with 55 DAT setpoint, plenum temperature is to control to 52 degrees.*

All AHUs shall be programmed to restart on their own without any software lockout reset required.

Reference University Standard 230553S02 for the AHU naming convention.

CHILLED WATER SYSTEMS

For buildings and installations that require a chilled water system decoupled loop, refer to University Standard 236000S01.

ROOM TERMINAL HVAC

For all rooms, provide the following points as a minimum:
VAV supply and/or return damper position
Heating valve position
CFM reading
Room DAT
Room temperature
Room temperature setpoint
Radiant Heat valve position (if applicable)

For any space that may be unoccupied during periods of operation, consideration needs to be given in the design of the space to the University Energy Guidelines.

HYDRONIC WATER SYSTEMS

All hydronic water systems shall be developed using an outside air temperature reset schedule developed for each particular building.

BACnet Protocol Implementation Conformance Statement:
The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for their BACnet Interface with their shop drawings. The interface shall comply with the following as a minimum.

Vendor Name: Tridium, Inc.
Product Family: Niagara Framework, including N4 Web Supervisor, JACE 6XX at Release 3.8, JACE 8xxx at release 4.6 or greater using the most current version of JAVA or HTML 5. All control work associated with this project must be fully compatible with this version of Tridium such that all alarms, points, etc. communicate and clear alarms seamlessly with the existing system.
Description: This product family provides bi-directional communication between the Tridium Niagara Framework and a BACnet system operating at BACnet Conformance Class 3, over Ethernet media.

BACnet Protocols are documented in Appendices A, B & C.

REQUIRED SUBMITTALS:

The following chart is supplied for the benefit of the Owner, Architect, Engineer and contractor to assure a complete submission of required information. It is a reference listing of documents required by the Specifications under this Section. Refer to Specifications Section - General Provisions for the general requirements of submittals.

ITEM	SHOP DRAWING	M&O MANUAL	PARTS LIST	WRITTEN DESCRIPTION
Control equipment	x	x	x	
Control systems	x			
Control sequence				x
“As-builts” drawings	x	x	x	
Frequency drives	x	x	x	
Air terminal units	x	x	x	
I/O Summary Charts	x			

Print and Save Excel I/O Summary Sheet in Spec Directory; Refer to drawings for points lists

VARIABLE FREQUENCY DRIVES (VFDs):

The work includes all labor, materials, and related items to completely furnish and install, start up and test, and place into service the Variable Frequency Drives indicated and scheduled on the Drawings and described in the Specifications.

Variable Frequency Drives shall be Pulse Width Modulation adjustable frequency AC drives as manufactured by ABB, Yaskawa or Eaton. The drives shall be 6 pulse drives at a minimum, with 3% impedance. The drive unit shall be UL listed as a complete assembly.

Each drive shall include the following features:

Factory mounted fused disconnect for overcurrent protection.

Human interface module (HIM) keypad factory mounted (not hand held). Panel mounted Hand/Off/Auto switch to allow manually switching between hand (manual control via HIM); off (drive off, motor off; and automatic (control via temperature control signal).

A mechanical interlock between the bypass and drive contactors.

A control transformer.

UL/CSA/CE labeled.

The rectifier stage shall convert fixed voltage, fixed frequency, AC line power to fixed DC voltage. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The rectifier shall be insensitive to phase rotation of the AC line. The DC voltage shall be filtered. The DC bus shall have external connections for standby battery back-up or for linking multiple AC drive buses. The inverter shall change fixed DC voltage to variable frequency AC. The inverter shall utilize IGBT's as required by the current rating of the motor.

The drives shall operate a variable torque load. The speed range shall be from a minimum of 0.5 Hz @ 100% breakaway torque to a maximum speed of 250 Hz.

The drives shall have UL Type 1 listed enclosures that allow operation in a Pollution Degree 3 environment and shall meet NEMA Type 1/1P30 or NEMA Open/P20. The drives shall meet IEC 664-1 and NEMA ICS 1-111A Part 3 standards.

The drives shall be designed to operate in an ambient temperature of 0 degrees C to 40 degrees C.

The drives shall meet IEC 68-2-6 vibration specification.

Drives 75 HP and smaller shall be designed and constructed for finger safe operation with the enclosure open to operator access according to IP20 standards.

The drives shall be designed to operate from an input voltage ranging from 380+/- 10% to 480 +/- 10%; and from an input frequency form 48 to 63 Hz.

The displacement power factor shall not be less than 0.98 lagging under any speed or condition.

The efficiency of the AC drive at 100% speed and load shall not be less than 97%.

Variable torque overtorque capacity of 110% for 1minute.

The output carrier frequency of the drive shall be randomly modulated and selectable at 4 kHz, or 8 kHz.

The output frequency shall be from 0.1 to 400 Hz for AC drives up to 75 HP. At horsepowers above 75 HP, the maximum output frequency shall be 200 Hz.

Upon power-up, the drives shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communications, dynamic brake failure, DC to DC power supply, control power, and the pre-charge circuit.

The drives shall be protected against short circuits between output phases; between output phases and ground; on the outputs, on the internal supplies, and on the logic and analog inputs.

For a fault condition other than a ground fault, short circuit, or internal fault, an auto restart function will provide a minimum of 5 programmable time delays before restart attempts; trial time will range from 1 second to 180 seconds.

The deceleration mode of the AC drive shall be programmable for normal and fault conditions. The stop modes shall include ramp to stop, free-wheel stop, fast stop, and DC injection braking.

A synchronized restart shall be provided that will catch a spinning motor by sensing the motor frequency and rotational direction and synchronize the AC output prior to restarting.

The drive shall be able to receive the control inputs for the smoke detection system to shut the fans down.

The manufacturer shall offer 24 hour product and application response via a nationwide network of factory certified technical support personnel.

A parts and labor warranty of 2 years from the date of substantial completion shall be included. Warranty shall include travel time and expenses.

Factory-authorized startup for each drive is mandatory. Provide a written record of the startup of each unit.

Auxiliary contacts for connection to local disconnect to shut down drive when disconnect is off.

INSTALLATION: Install all equipment in accordance with the manufacturers' recommendations. Drives are to be wall mounted.

Start up and programming by a factory-authorized technician.

MAINTENANCE AND OPERATING INSTRUCTIONS: Provide one (1) hard copy and (1) electronic copy of maintenance and operating instructions for each piece of equipment furnished. The (1) hard copy shall be in a 3-ring binder, and both hard copy and electronic copy shall contain a copy of the approved shop drawings or catalog cuts of all equipment, as well as maintenance and operating instructions from the equipment manufacturers.

Instruct Owner's personnel in the operation of the equipment. Refer to 15900-6 4.6.

ADJUSTMENT AND SERVICE

After completion of the installation, the automatic temperature control manufacturer shall regulate and adjust all thermostats, control valves, motors, and other equipment provided under his contract and shall place them in complete operating condition, subject to approval by the Architect and

Owner.

This shall include but not be limited to “tuning” of all control systems. Systems shall be tuned for decaying wave response and minimal overshoot of setpoint.

Room temperature controls shall have one temperature setpoint with less than a 0.25°F between calculated heating and cooling temperatures.

This Contractor shall work with the Balancing Contractor to provide verification of CFM reading from the DDC terminal unit controllers.

Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

After completion of installation, perform the following:

Installation:

Check proper installation and connection of each control device.

Verify electric power.

Verify each sensor and actuator connection to field computer.

Field Computer Operation.

Point Test

Check of wiring of each sensor and actuator end-to-end

Verify calibration of each sensor.

Verify manual operation of each acturator.

Local Loop Control

Bring each local loop under control.

Check response to upset, change in setpoint.

Check full and partial load operation.

Supervisory function

Verify time clock schedules.

Verify reset control.

Verify Host Computer Operation.

Verify communication with each field device.

Perform end-to-end sensor and actuator checks.

Verify that the database is correct.

Test other Software.

Trend Logging.

Report Generation.

Remote Access.

System Documentation.

Verify proper operation of every control point in the presence of the Engineer. Include point-by-point checkout.

The control manufacturer shall provide a period of free service extending through one complete heating season and one complete cooling season after acceptance of the control system, and shall report the condition of the control equipment to the Owner and the Architect.

Appendix A – Vykon Niagara Compatibility Statement (NiCS)

VYKON Niagara^{AX} Compatibility Statement (NiCS) Includes all VYKON branded JACE and Software Products

VYKON Niagara^{AX} Compatibility Statement (NiCS)

Includes all VYKON branded JACE and Software Products

The following information describes Tridium's VYKON branded Niagara^{AX} product licensing.

Tridium's VYKON AX branded products utilizes an open access licensing procedure. VYKON AX branded products can be connected to and managed by any Niagara based tools or systems without the need to modify the license. This means the end user does not have to authorize changes to a VYKON AX license for another systems integrator to gain access to the system. The end user does need to have the necessary user names and passwords installed by the original system integrator so they can be used by another Niagara trained system integrator.

The following is an explanation of the VYKON licensing scheme.

BrandID

Every licensed station and tool has a Brand Identifier (BrandID). This field holds a text descriptor that the OEM chooses as the identifier for its product line. Each station or tool can have only one BrandID entry.

Tridium's VYKON products have the following:

BrandID – VYKON

Station Compatibility In

This field is a list of brands that this local station will allow Niagara AX data to come in from. Simply stated from the point of view of a JACE, "this is the list of brands that can I can accept data from". Tridium's VYKON products contain:

Station Compatibility In – All (In the actual license ALL is define by an *)

Note: The compatibility fields can contain; a single brand "ABC", a list of multiple brands "ABC, XYZ", no brand

"None" or all brands "All".

Station Compatibility Out

This field is a list of brands that this local station will allow Niagara AX data to be shared with. Simply stated, "This is the list of brands that I can share data with". Tridium's VYKON products contain:

Station Compatibility Out – All

Tool Compatibility In

This field is a list of brands that this station will allow to be connected to it for engineering of its application. Simply stated, "This is the list of brands that can engineer me". Tridium's VYKON products contain:

Tool Compatibility In – All

Tool Compatibility Out

This field is a list of brands that this tool is allowed to connect to and engineer. Simply stated, "This is the list of brands that I can engineer". Tridium's VYKON products contain:

Tool Compatibility Out – All

As long as VYKON branded products are purchased by the end user any Tridium Certified (TCP) system integrator can provide support for the end user without the need for the owner to be involved in the licensing process. For more information on Niagara Connectivity and Security visit our website library at: http://www.vykon.com/cs/library/white_papers

Management Contacts:
Scott Boehm
Director, VYKON Automation Energy Security
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Appendix B – Tridium Niagara 3.8 BACnet PICS

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TRIDIUM NIAGARA AX 3.8
BACnet PICS

BACnet Protocol Implementation Conformance Statement

Date: August 31, 2016
Vendor Name: Tridium
Product Name: Niagara AX BACnet Integration
Product Model Number: Tridium JACE models
Application Software Version: 3.8.112 or higher
Firmware Revision: 3.8.112.1 or higher
BACnet Protocol Revision: 7

Product Description:
Niagara AX provides the ability to view, monitor, and control BACnet devices over IP, raw Ethernet, or MS/TP media. Devices, points, schedules, alarms, and logs can be learned and managed from Niagara AX. In addition, Niagara points, schedules, histories, and alarming can be exposed to BACnet for monitor and control by foreign BACnet clients.

BACnet Standardized Device Profile (Annex L):

☐ **BACnet Advanced Operator Workstation (B-AWS)**
☐ **BACnet Operator Workstation (B-OWS)**
☐ **BACnet Operator Display (B-OD)**
☒ **BACnet Building Controller (B-BC)**
☐ **BACnet Advanced Application Controller (B-AAC)**
☐ **BACnet Application Specific Controller (B-ASC)**
☐ **BACnet Smart Sensor (B-SS)**
☐ **BACnet Smart Actuator (B-SA)**

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Additional BACnet Interoperability Building Blocks Supported (Annex K):

Data Sharing DS-RP-A, B DS-RPM-A, B DS-WP-A, B DS-WPM-A, B DS-COV-A, B DS-COVU-A, B DS-V-A DS-M-A DS-COVP-B	**Device & Network Management** DM-DDB-A, B DM-DOB-A, B DM-DCC-B DM-RD-B DM-TS-B DM-UTC-B DM-LM-A, B DM-BR-B DM-ANM-A DM-ADM-A DM-ATS-A DM-MTS-A
Alarm & Event Management AE-N-A, -I-B AE-ACK-A, B AE-ASUM-B AE-ESUM-B AE-INFO-B AE-VN-A AE-VM-A	**Trending** T-VMT-A, I-B, -E-B T-ATR-A, B T-V-A
Scheduling SCHED-A, I-B, -E-B SCHED-VM-A SCHED-WS-I-B	**Network Management** NM-CE-A

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Segmentation Capability:

Feature	Supported	Window size
Transmit Segmented Messages	yes	10
Receive Segmented Messages	yes	any

Standard Object Types Supported:

- The CreateObject and DeleteObject services are not supported, so no objects are dynamically creatable or deletable through BACnet service requests, although these objects are dynamically creatable and deletable through Niagara.
- No general range restrictions exist; however, certain specific applications may have specific range restrictions.
- All potentially available properties are listed for each object type.
- Optional properties are listed in *italics*. Not all instances support all optional properties.
- Writable properties are listed in **bold**. Any range limitations are expressed in parentheses following the property name.

Notes from Table

1. The File_Size property of File objects is only writable if the underlying system file is changeable.
2. The Setpoint property of Loop objects is writable only if the setpoint is not linked from within Niagara.
3. The Recipient_List property of the Notification Class object will maintain entries that are internally configured within Niagara.
4. The List_Of_Object_Property_References property of the Schedule object will maintain entries that are internally configured within Niagara.
5. The Priority_For_Writing property of Schedule objects is not important for internal Niagara operation, as the priority at which a point is commanded is determined by the input to which the Schedule output is linked.
6. These Trend Log object properties are not writable if the backing history for the exported Trend Log is a Niagara-generated history. If the history is created as a BACnet Trend Log, then they are writable.
7. Trend Logs in Niagara use internal triggering and are either COV or Interval. So the Log_Interval property cannot be written from BACnet.

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Object Type	Properties	
Analog Input	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Units *Min_Pres_Value* *Max_Pres_Value*	*Resolution* ***COV_Increment*** ***Time_Delay*** *Notification_Class* ***High_Limit*** ***Low_Limit*** ***Deadband*** ***Limit_Enable*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Analog Output	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Units *Min_Pres_Value* *Max_Pres_Value* *Resolution*	Priority_Array **Relinquish_Default** ***COV_Increment*** ***Time_Delay*** *Notification_Class* ***High_Limit*** ***Low_Limit*** ***Deadband*** ***Limit_Enable*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Analog Value	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** Units *Priority_Array* ***Relinquish_Default***	***COV_Increment*** ***Time_Delay*** *Notification_Class* ***High_Limit*** ***Low_Limit*** ***Deadband*** ***Limit_Enable*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Object Type	Properties	
Binary Input	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Polarity ***Inactive_Text*** ***Active_Text***	*Change_Of_State_Time* ***Change_Of_State_Count*** (0) *Time_Of_State_Count_Reset* ***Elapsed_Active_Time*** (0) *Time_Of_Active_Time_Reset* ***Time_Delay*** ***Notification_Class*** ***Alarm_Value*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Binary Output	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Polarity ***Inactive_Text*** ***Active_Text*** *Change_Of_State_Time* ***Change_Of_State_Count*** (0)	*Time_Of_State_Count_Reset* ***Elapsed_Active_Time*** (0) *Time_Of_Active_Time_Reset* ***Minimum_Off_Time*** ***Minimum_On_Time*** Priority_Array **Relinquish_Default** ***Time_Delay*** ***Notification_Class*** *Feedback_Value* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Binary Value	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** ***Inactive_Text*** ***Active_Text*** *Change_Of_State_Time* **Change_Of_State_Count** *(0)* *Time_Of_State_Count_Reset*	***Elapsed_Active_Time*** (0) *Time_Of_Active_Time_Reset* ***Minimum_Off_Time*** ***Minimum_On_Time*** *Priority_Array* ***Relinquish_Default*** ***Time_Delay*** ***Notification_Class*** ***Alarm_Value*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Object Type	Properties	
Calendar	Object_Identifier	***Description***
	Object_Name	Present_Value
	Object_Type	**Date_List**
Device	Object_Identifier	Segmentation_Supported
	Object_Name	*Max_Segments_Accepted*
	Object_Type	*Local_Time*
	System_Status	*Local_Date*
	Vendor_Name	*UTC_Offset*
	Vendor_Identifier	*Daylight_Savings_Status*
	Model_Name	*APDU_Segment_Timeout*
	Firmware_Revision	APDU_Timeout
	Application_Software_Revision	Number_Of_APDU_Retries
	Location	*Max_Master*
	Description	*Max_Info_Frames*
	Protocol_Version	Device_Address_Binding
	Protocol_Revision	Database_Revision
	Protocol_Services_Supported	*Configuration_Files*
	Protocol_Object_Types_Supported	*Last_Restore_Time*
	Object_List	***Backup_Failure_Timeout***
	Max_APDU_Length_Accepted	*Active_COV_Subscriptions*
File (Stream Access Only)	Object_Identifier	**File_Size**[1]
	Object_Name	Modification_Date
	Object_Type	**Archive**
	Description	Read_Only
	File_Type	File_Access_Method

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Powered by niagara AX FRAMEWORK

Object Type	Properties	
Loop	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** Output_Units Manipulated_Variable_Reference Controlled_Variable_Reference Controlled_Variable_Value Controlled_Variable_Units Setpoint_Reference **Setpoint**[2] Action ***Proportional_Constant***	*Proportional_Constant_Units* ***Integral_Constant*** *Integral_Constant_Units* ***Derivative_Constant*** *Derivative_Constant_Units* ***Bias*** ***Maximum_Output*** ***Minimum_Output*** Priority_For_Writing ***COV_Increment*** ***Time_Delay*** *Notification_Class* ***Error_Limit*** *Event_Enable* *Acked_Transitions* *Notify_Type* *Event_Time_Stamps*
Multi-state Input	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service**	Number_Of_States ***State_Text*** ***Time_Delay*** ***Notification_Class*** ***Alarm_Values*** *Fault_Values* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Multi-state Output	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Number_Of_States	***State_Text*** Priority_Array **Relinquish_Default** ***Time_Delay*** ***Notification_Class*** *Feedback_Value* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Object Type	Properties	
Multi-state Value	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** Number_Of_States	***State_Text*** *Priority_Array* ***Relinquish_Default*** ***Time_Delay*** ***Notification_Class*** ***Alarm_Values*** *Fault_Values* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Notification Class	Object_Identifier **Object_Name** Object_Type ***Description***	Notification_Class **Priority** **Ack_Required** **Recipient_List**[3]
Schedule	Object_Identifier **Object_Name** Object_Type ***Description*** **Effective_Period** ***Weekly_Schedule*** ***Exception_Schedule***	**Schedule_Default** **List_Of_Object_Property_References**[4] **Priority_For_Writing**[5] Status_Flags Reliability **Out_Of_Service**
Trend Log	Object_Identifier **Object_Name** Object_Type ***Description*** **Log_Enable**[6] ***Start_Time*** ***Stop_Time*** *Log_DeviceObjectProperty* ***Log_Interval***[6, 7] *COV_Resubscription_Interval* *Client_COV_Increment* Stop_When_Full Buffer_Size	Log_Buffer **Record_Count** (0)[6] Total_Record_Count *Notification_Threshold* *Records_Since_Notification* *Last_Notify_Record* Event_State ***Notification_Class*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Data Link Layer Options:

☒ BACnet IP, (Annex J)
☒ BACnet IP, (Annex J), Foreign Device
☒ ISO 8802-3, Ethernet (Clause 7)
☐ ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ANSI/ATA 878.1, RS-485 ARCNET (Clause 8), baud rate(s) _____
☒ MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 76800
☐ MS/TP slave (Clause 9), baud rate(s): _____
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s):_____
☐ Point-To-Point, modem, (Clause 10), baud rate(s): _____
☐ LonTalk, (Clause 11), medium: _____
☐ Other:

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☒Yes ☐ No

Networking Options:

☒ Router, Clause 6 – Routing configurations: Ethernet-IP, Ethernet-MS/TP, IP-MS/TP
☐ Annex H, BACnet Tunneling Router over IP
☒ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☒ Yes ☐ No

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☒ ANSI X3.4	☐ IBM™/Microsoft™ DBCS	☒ ISO 8859-1
☒ ISO 10646 (UCS-2)	☐ ISO 10646 (UCS-4)	☐ JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:
This product supports communications between BACnet and any third-party system to which Niagara can connect. Contact Tridium for a list of supported protocols.

Appendix C – BACnet Testing Laboratories Product Listing

BACnet Testing Laboratories Product Listing

This product has been tested at a qualified BACnet Testing Laboratory and found to comply with all the necessary interoperability requirements in place on the published test date. This listing represents the tested capability of the Listed Product. For information on additional functionality that was not covered in the test process, refer to the Manufacturer's PICS statement on the BI website.

Listing Information

Vendor		Listing Status
Tridium, Inc. 3951 Westerre Parkway, Suite 350 Richmond, VA 23233 USA		Listed Product
Test Requirements	BACnet Protocol Revision	Date Tested
Requirements as of July 2009	Revision 7 (135-2008)	July 2011

Product Name	Model Number(s)	Software Version
Niagara AX Supervisor with BACnet B-AWS	S-AX-AWS	3.6.35

Device Profiles

Profile	Model Numbers
BACnet Advanced Workstation (B-AWS)	S-AX-AWS

BIBBs Supported

Data Sharing	ReadProperty-A	DS-RP-A
	ReadProperty-B	DS-RP-B
	ReadPropertyMultiple-A	DS-RPM-A
	ReadPropertyMultiple-B	DS-RPM-B
	WriteProperty-A	DS-WP-A
	WriteProperty-B	DS-WP-B
	WritePropertyMultiple-A	DS-WPM-A
	WritePropertyMultiple-B	DS-WPM-B
	COV-A	DS-COV-A
	View-A	DS-V-A
	Advanced View-A	DS-AV-A
	Modify-A	DS-M-A
	Advanced Modify-A	DS-AM-A

Alarm and Event Management	Alarm and Event-Notification-A	AE-N-A
	Alarm and Event-ACK-A	AE-ACK-A
	Alarm and Event-View Notifications-A	AE-VN-A
	Alarm and Event-Advanced View Notifications-A	AE-AVN-A
	Alarm and Event-View and Modify-A	AE-VM-A
	Alarm and Event-Advanced View and Modify-A	AE-AVM-A
	Alarm and Event-Alarm Summary View-A	AE-AS-A
	Alarm and Event-Event Log View and Modify-A	AE-ELVM-A

Scheduling	Scheduling-View and Modify-A	SCHED-VM-A
	Scheduling-Advanced View and Modify-A	SCHED-AVM-A
	Scheduling-Weekly Schedule-A	SCHED-WS-A

Trending	Trending-View-A	T-V-A
	Trending-Advanced View and Modify-A	T-AVM-A
	Automated Trend Retrieval-A	T-ATR-A

Device and Network Management	Dynamic Device Binding-A	DM-DDB-A
	Dynamic Device Binding-B	DM-DDB-B
	Dynamic Object Binding-A	DM-DOB-A
	Dynamic Object Binding-B	DM-DOB-B
	Automatic Device Mapping-A	DM-ADM-A
	Automatic Network Mapping-A	DM-ANM-A
	Time Synchronization-A	DM-TS-A
	Time Synchronization-B	DM-TS-B
	UTC Time Synchronization-A	DM-UTC-A
	UTC Time Synchronization-B	DM-UTC-B
	Automatic Time Synchronization–A	DM-ATS-A
	Manual Time Synchronization–A	DM-MTS-A
	DeviceCommunicationControl-A	DM-DCC-A
	DeviceCommunicationControl-B	DM-DCC-B
	ReinitializeDevice-A	DM-RD-A
	ReinitializeDevice-B	DM-RD-B
	Backup and Restore-A	DM-BR-A
	Restart-A	DM-R-A
	Object Creation and Deletion-A	DM-OCD-A
	List Manipulation-A	DM-LM-A
	List Manipulation-B	DM-LM-B

Object Type Support

Device		

Data Link Layer Options

Media	Options
BACnet/IP (Annex J)	BBMD
Ethernet	

Networking Options

Networking Functionality	Media
Router	BACnet/IP (Annex J) – Ethernet

Character Set Support

ANSI X3.4
ISO 10646 (UCS-2)

END OF SECTION 250200

SECTION 250300 - ENERGY METERS

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 thermal and electric power energy meters that connect to DDC systems.

B. Related Requirements:

1. Section 250200 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 DEFINITIONS

A. DDC: Direct-digital control.

B. Ethernet: Local area network based on IEEE 802.3.1 standards.

C. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

D. I/O: Input/output.

E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

F. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.

G. RS-485: A TIA standard for multipoint communications using two twisted pairs.

H. RTD: Resistance temperature detector.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating electrical power requirements.

3. Product description with complete technical data, performance curves, and product specification sheets.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product 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.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For energy meters to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 UTILITY ENERGY METERS

A. Manufacturers: The required energy meters for the energy sources listed below shall be as follows:
1. Natural gas - ONICON F-5500
2. Domestic cold water - ONICON F-4600
3. Steam Condensate – ONICON F-4600
4. AC Condensate – ONICON FT-3000
5. Chilled Water – ONICON F-3500
6. Electrical Power - Schneider METSEPM5560 and METSEPM5563RD

B. For insertion type meters, temperature ranges for the specified meters shall be chosen to match the application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Support instruments, tubing, piping wiring, and conduit to comply with requirements indicated.

C. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper meter operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record videos on DVD disks.

D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.13

TAGGED NOTES

IC1	PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.
IC3	ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-LL-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.
IC4	ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-LL-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.
IC17	REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.
IC26	CONTROLS CONTRACTOR TO INSTALL BOILER CONTROL PANEL AND ALL NECESSARY INTEGRATION. BOILER CONTROL PANEL PROVIDED BY THE BOILER MANUFACTURE.
IC27	ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.
IC28	CONTROLS CONTRACTOR TO PROVIDE AND INSTALL FIRE CONTROL PANEL AND INTEGRATE INTO BAS.
IC30	FIRE PUMP CONTROLLER TO BE INTEGRATED AND MONITORED BY THE BAS.
IC31	2 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
IC32	3 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
IC33	4 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
IC44	5 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
	THERMOSTAT SHALL BE NON-METALLIC, MRI SAFE DEVICE.

1 CONTROLS PLAN - LEVEL 00
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

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Lexington, KY 40536

UK Project Number 2563.0

ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

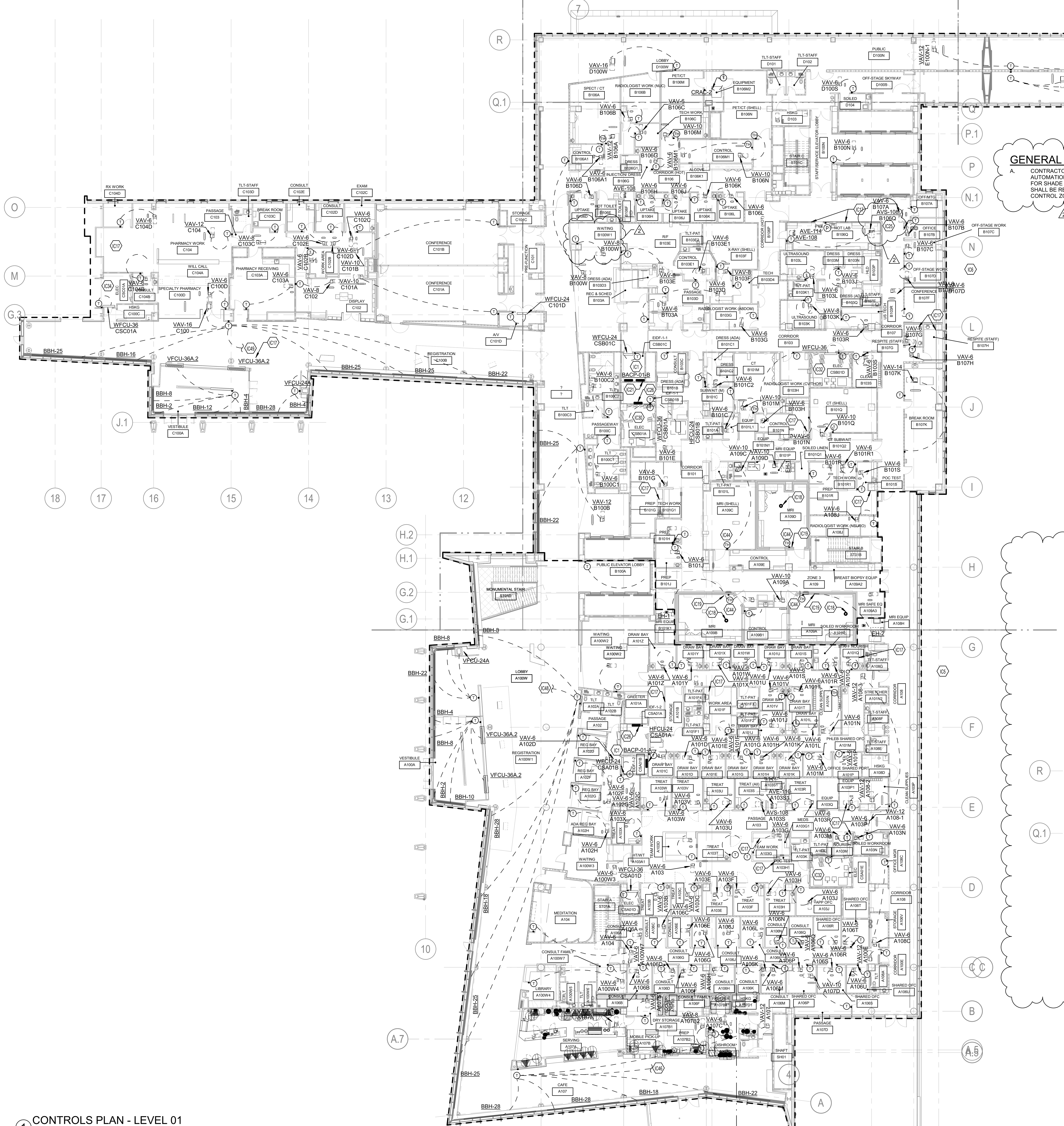
DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 00

SHEET NO.

IC100

9/30/2024 6:21:24 PM



1 CONTROLS PLAN - LEVEL 01
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

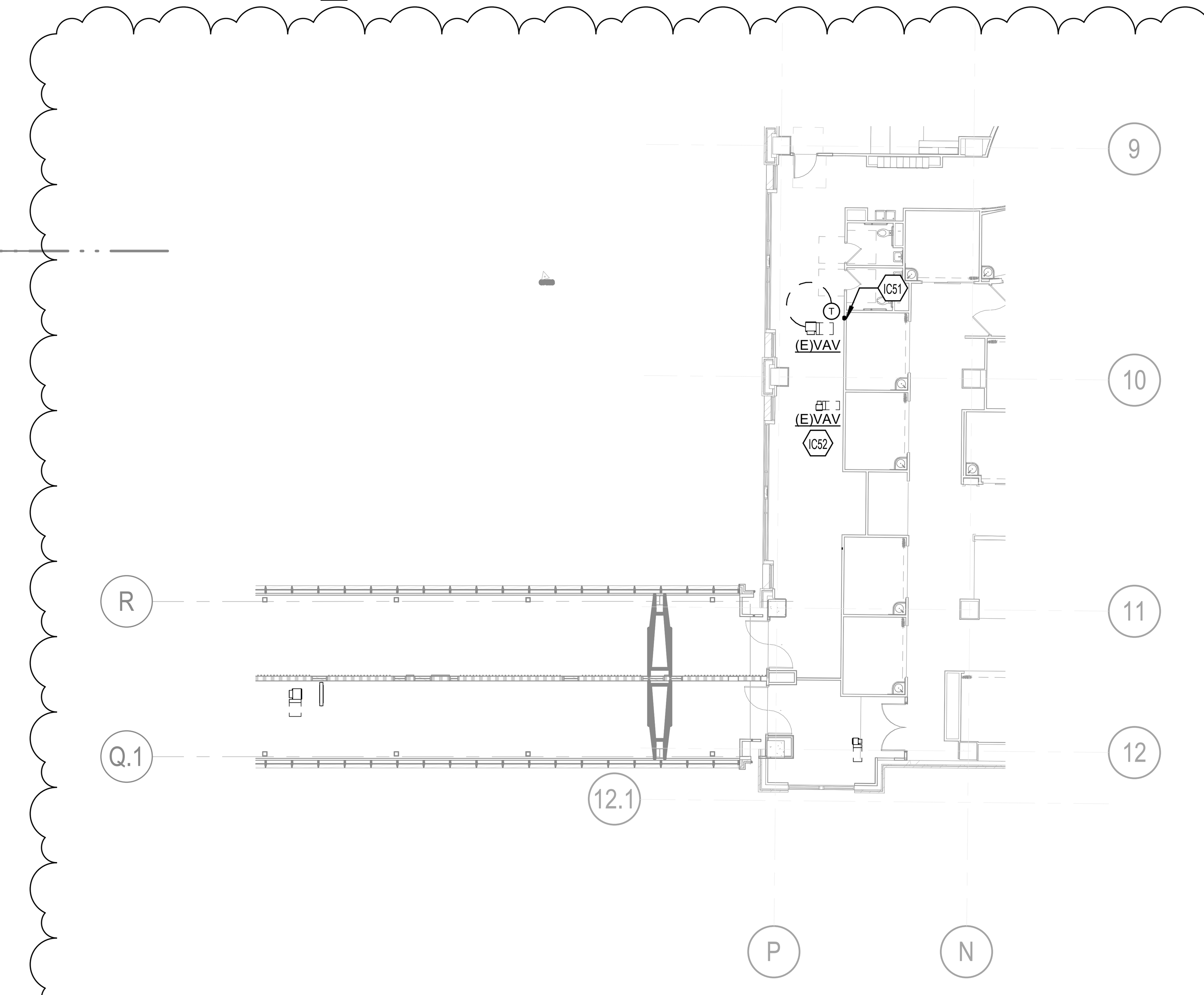
GENERAL NOTES:

A. CONTRACTOR TO INTEGRATE MECO SHADES INTO BUILDING AUTOMATION SYSTEM. REFER TO ARCHITECTURAL DRAWINGS FOR SHADE LOCATIONS AND SPECIFICATIONS. CONTRACTOR SHALL BE RESPONSIBLE FOR DRY CONTACTS TO EACH OF THE 33 CONTROL ZONES. CONTROL IS TO BE BY TIME OF DAY CLOCK.

TAGGED NOTES

##

IC1	PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.
IC5	ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-01-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.
IC6	ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-01-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.
IC17	REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.
IC18	PROVIDE AND INSTALL CEILING MOUNTED REMOTE OXYGEN SAMPLING PROBE.
IC19	EMERGENCY EXHAUST PUSH BUTTON MOUNTED ON WALL. PROVIDE ENGRAVED MARKING THAT READS "MRI EMERGENCY EXHAUST FAN ENABLED".
IC21	PROVIDE AND INSTALL PHOENIX CONTROL PANEL. ALL PHOENIX VALVES ON LEVEL 1 SHALL REPORT TO THIS PANEL.
IC25	VALVE TO BE PROVIDED WITH BOTTOM ACCESS.
IC26	ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.
IC30	2 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
IC32	4 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
IC34	1 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
IC44	THERMOSTAT SHALL BE NON-METALLIC, MRI SAFE DEVICE.
IC46	THERMOSTAT SHALL REPORT TO "VAV A107-1" REFER TO SHEET IC 102.
IC48	THERMOSTAT SHALL REPORT TO "VAV A100W-1" AND "VAVA200W-2" REFER TO SHEET IC 102.
IC49	THERMOSTAT SHALL REPORT TO "VAV C100B-1" "VAV C100B-2" "VAV C100B-3" AND "VAV C100B-4" REFER TO SHEET IC102.
IC51	CONTRACTOR TO RELOCATE EXISTING THERMOSTAT TO AREA SHOWN.
IC52	EXISTING VAV AND EXISTING THERMOSTAT TO REMAIN.



2 CONTROLS PLAN - LEVEL 01 - AREA F
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

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UK Project Number 2563.0

ISSUANCES

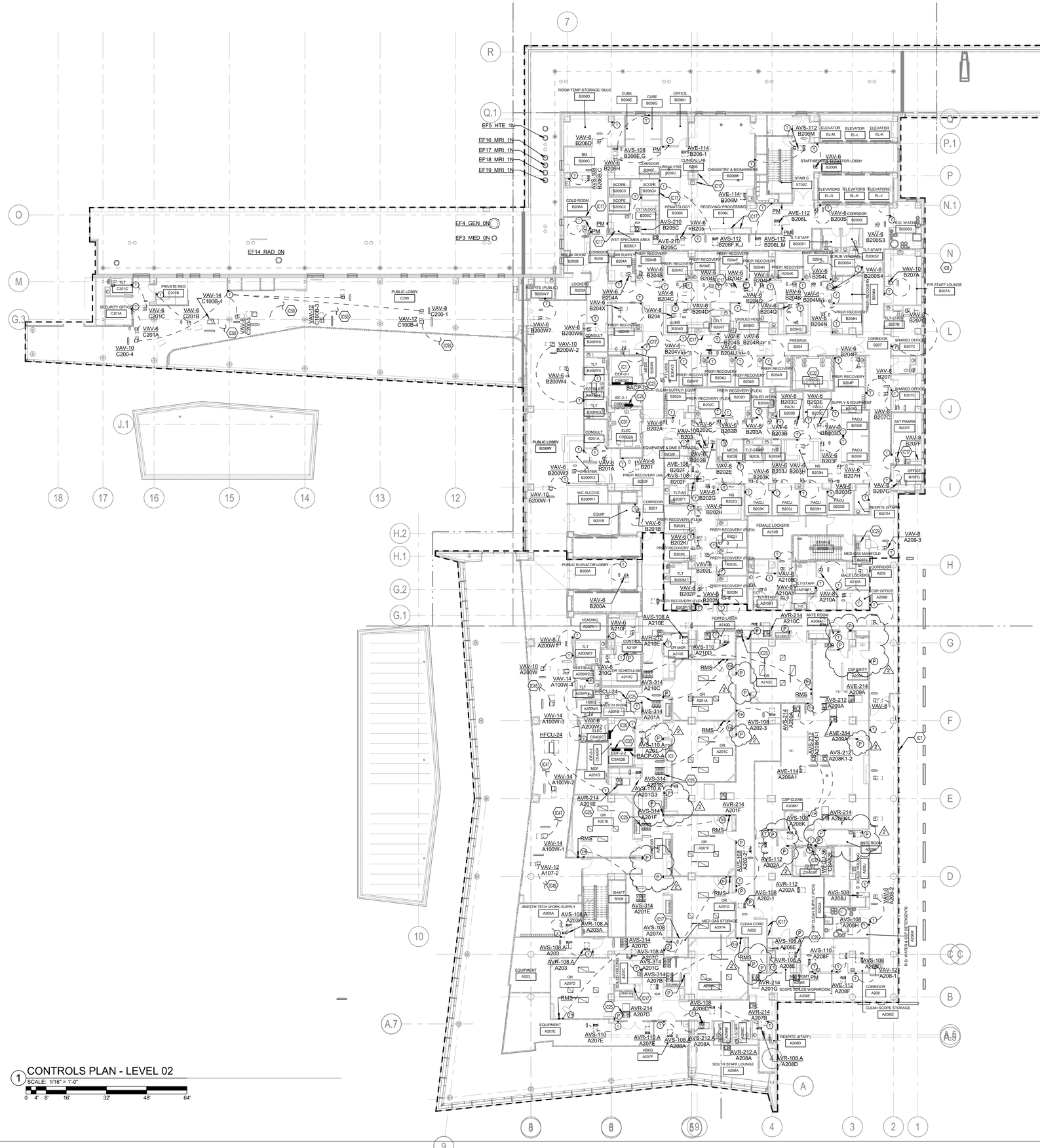
No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By KAS
Checked By SAC
Client Number 514
Project Number 6926

DRAWING TITLE
MECHANICAL CONTROLS - LEVEL 01

SHEET NO.
IC101

9/30/2024 6:21:38 PM



1 CONTROLS PLAN - LEVEL 02
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

TAGGED NOTES

IC1 PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.

IC7 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-02-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC8 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-02-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC17 REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.

IC22 PROVIDE AND INSTALL PHOENIX CONTROL PANEL. ALL PHOENIX VALVES ON LEVEL 2 AREA A SHALL REPORT TO THIS PANEL.

IC23 PROVIDE AND INSTALL PHOENIX CONTROL PANEL. ALL PHOENIX VALVES ON LEVEL 2 AREA B SHALL REPORT TO THIS PANEL.

IC25 VALVE TO BE PROVIDED WITH BOTTOM ACCESS.

IC26 ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.

IC29 MEDICAL GAS MANIFOLD SCALES TO BE INTEGRATED AND MONITORED BY THE BAS VIA BACNET OVER MSTP CONNECTION. IF LOW WEIGHT IS DETECTED AN ALARM SHALL BE SIGNALED TO THE BAS.

IC31 2 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.

IC32 4 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.

IC45 VAV SHALL REPORT TO THERMOSTAT IN "CAFÉ A107" REFER TO SHEET IC101.

IC47 VAV SHALL REPORT TO THERMOSTAT IN "LOBBY A100W" REFER TO SHEET IC 101.

IC50 VAV SHALL REPORT TO THERMOSTAT IN "LOBBY C100" REFER TO SHEET IC 101.

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No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 02

SHEET NO.

IC102

9/30/2024 6:21:53 PM

TAGGED NOTES

2

IC1 PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.

IC17 REFRIGERATOR/FREEZER TO BE MONITORED BY DDC. CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR. COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.

IC26 ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.

IC32 ENERGY METERS. CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.

12.1

12.2

1 CONTROLS PLAN - LEVEL 03

SCALE: 1/16" = 1'-0"

0 4' 8' 16' 32' 48' 64'

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Checked By	SAC
Client Number	514
Project Number	6926

DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 03

SHEET NO.

IC103

TAGGED NOTES

##

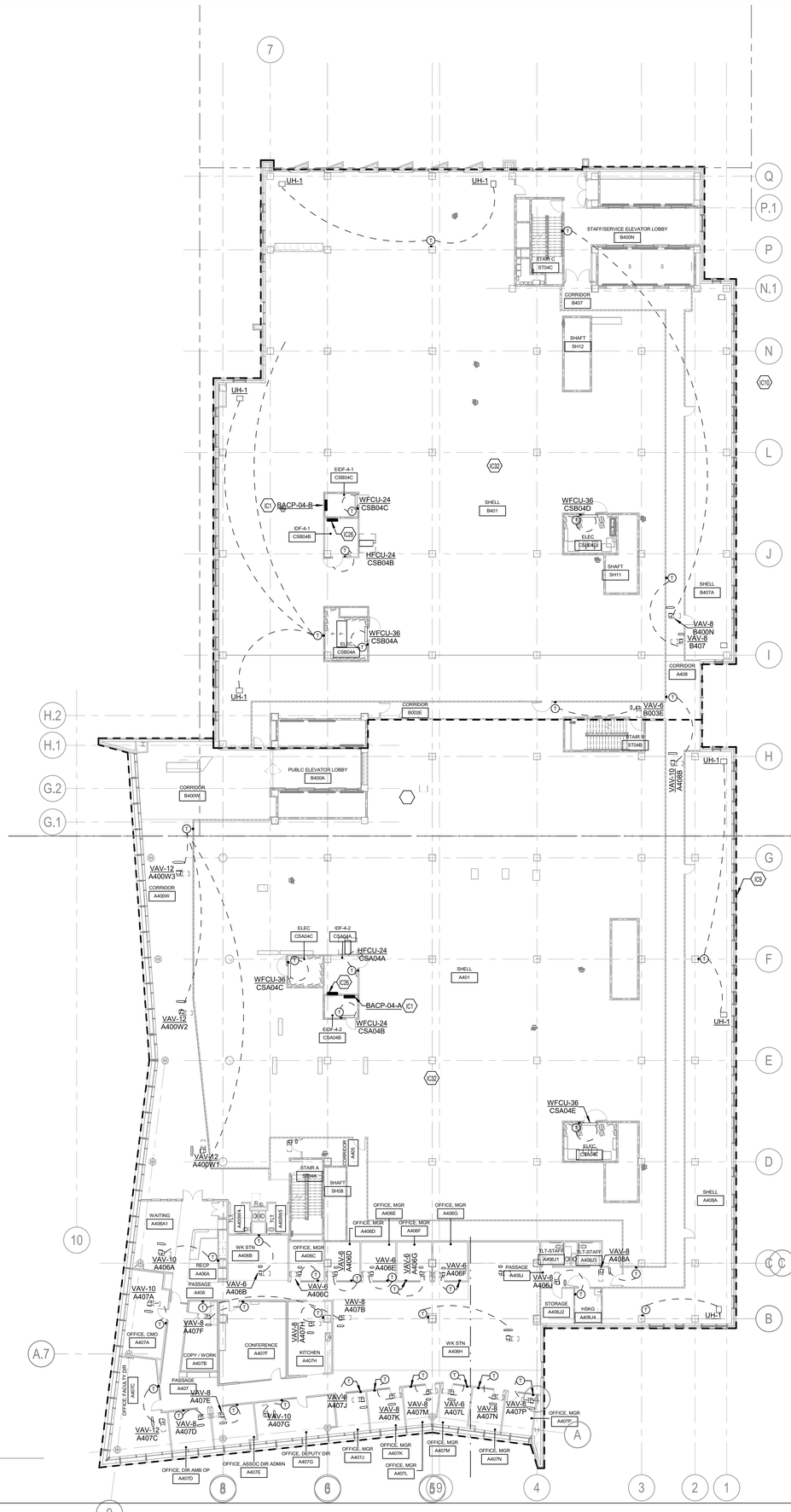
IC1 PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.

IC9 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-04-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC10 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-04-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC26 ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.

IC32 4 ENERGY METERS. CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.



1 CONTROLS PLAN - LEVEL 04
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

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UK Project Number 2563.0

ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

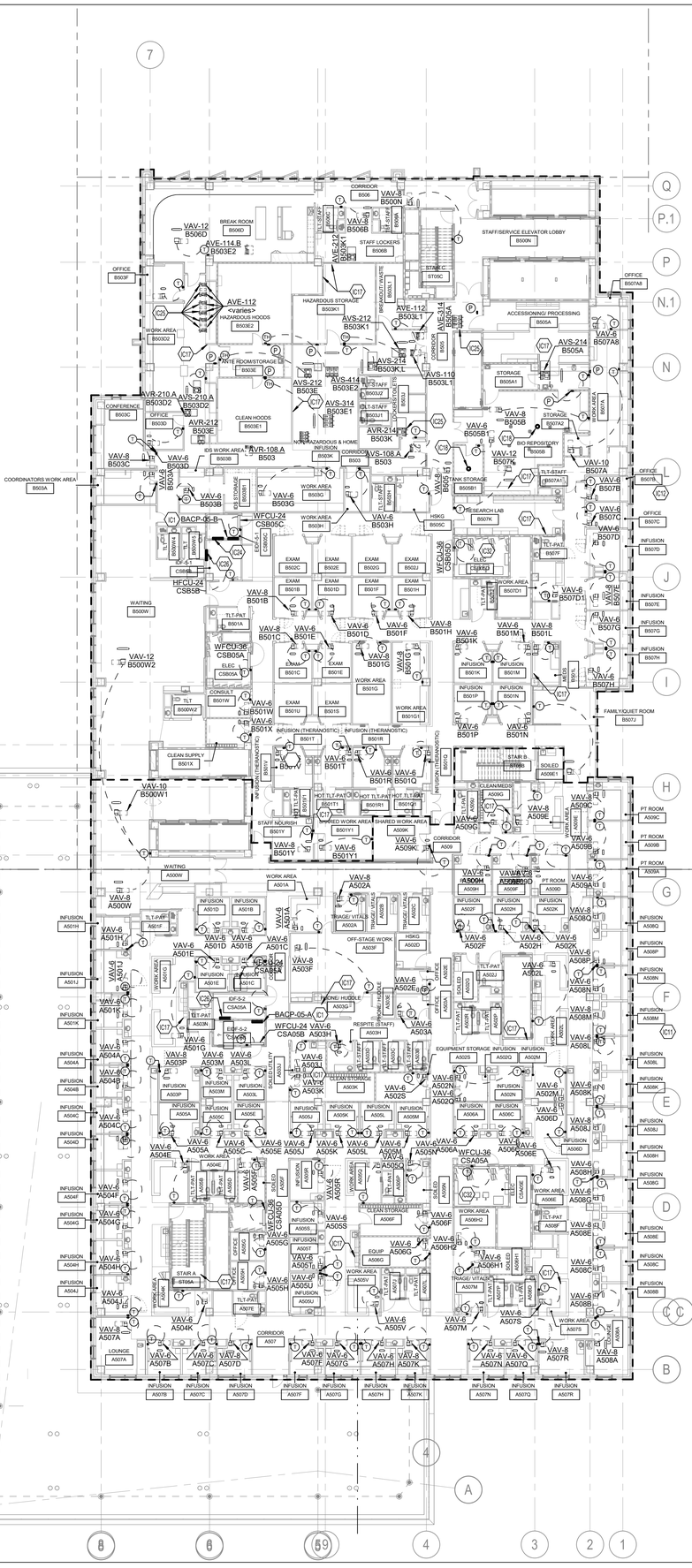
DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 04

SHEET NO.

IC104

10/1/2024 9:02:17 AM



TAGGED NOTES

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IC1 PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.

IC11 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-05-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC12 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-05-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC17 REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR. COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.

IC18 PROVIDE AND INSTALL CEILING MOUNTED REMOTE OXYGEN SAMPLING PROBE.

IC24 PROVIDE AND INSTALL PHOENIX CONTROL PANEL. ALL PHOENIX VALVES ON LEVEL 5 SHALL REPORT TO THIS PANEL

IC25 VALVE TO BE PROVIDED WITH BOTTOM ACCESS

IC26 ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS

IC32 4 ENERGY METERS. CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.

1 CONTROLS PLAN - LEVEL 05

SCALE: 1/16" = 1'-0"

0 4' 8' 16' 32' 48' 64'

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ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 05

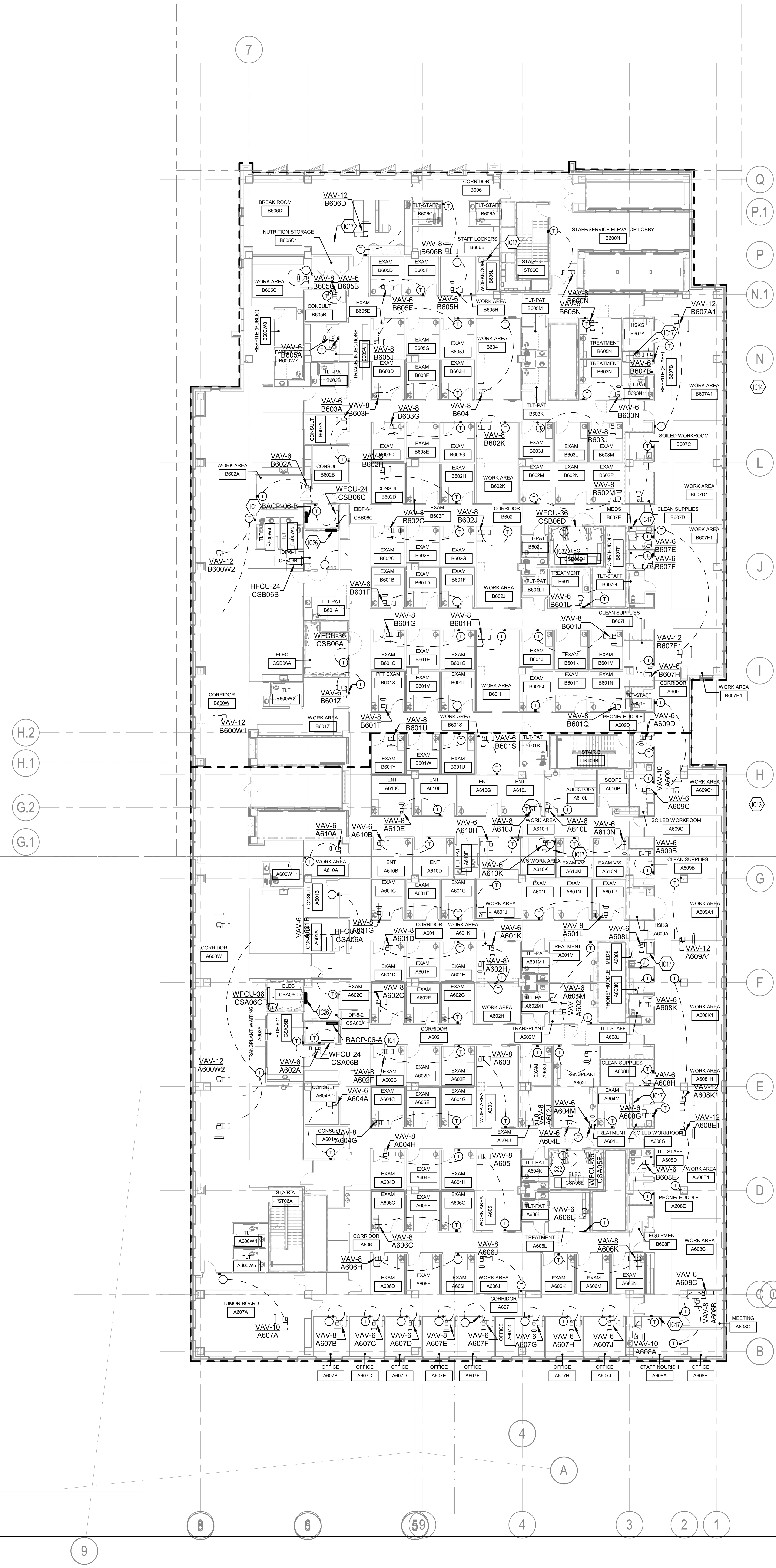
SHEET NO.

IC105

KAS 10/1/2024 9:02:37 AM Autodesk Docs://514.6926 - UHHC Cancer Treatment & Advance Ambulatory Center/M23-UHC_514R26.rvt
10/1/2024 9:02:37 AM

TAGGED NOTES

IC1	PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.
IC13	ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-06-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.
IC14	ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-06-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.
IC17	REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.
IC26	ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.
IC32	4 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.



1 CONTROLS PLAN - LEVEL 06
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

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ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

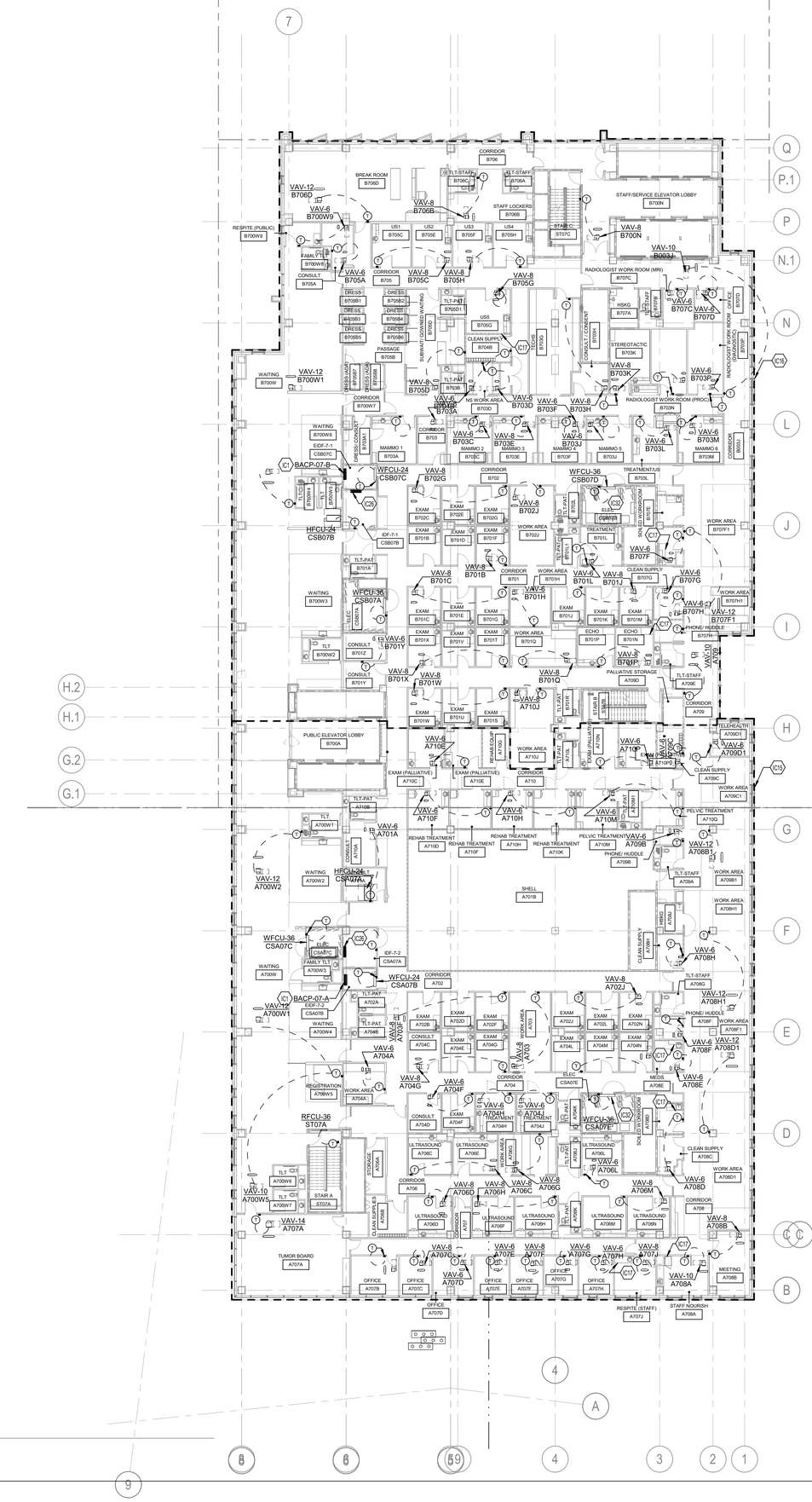
DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 06

SHEET NO.

IC106

10/1/2024 9:02:56 AM
KAS 10/1/2024 9:02:56 AM Autodesk Docs://514-6926 - UKHC Cancer Treatment & Advance Ambulatory Center/M23-UKC_5146926.rvt



TAGGED NOTES

IC1 PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.

IC15 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-07-A REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC16 ALL CONTROLS POINTS IN THE OUTLINED AREA TO REPORT TO BACP-07-B REFER TO BP-08 FIT-OUT DRAWINGS FOR EQUIPMENT SCHEDULES AND SPECIFICATIONS IN THE OUTLINED AREA.

IC17 REFRIGERATOR/FREEZER TO BE MONITORED BY DDC, CONTROLS CONTRACTOR TO PROVIDE AND INSTALL REFRIGERATOR/FREEZER TEMPERATURE MONITORS. MEDICAL REFRIGERATORS/FREEZERS SHALL BE PROVIDED WITH PORT TO INTEGRATE TEMEPRATURE SENSOR, COORDINATE WITH MEDICAL EQUIPMENT PACKAGE. PROVIDE HIGH TEMPERATURE ALARM. FIELD VERIFY LOCATION AND CONFIRM WITH MEDICAL EQUIPMENT PROVIDER.

IC26 ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.

IC32 4 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR

1 CONTROLS PLAN - LEVEL 07
SCALE: 1/16" = 1'-0"
0 4' 8' 16' 32' 48' 64'

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ISSUANCES

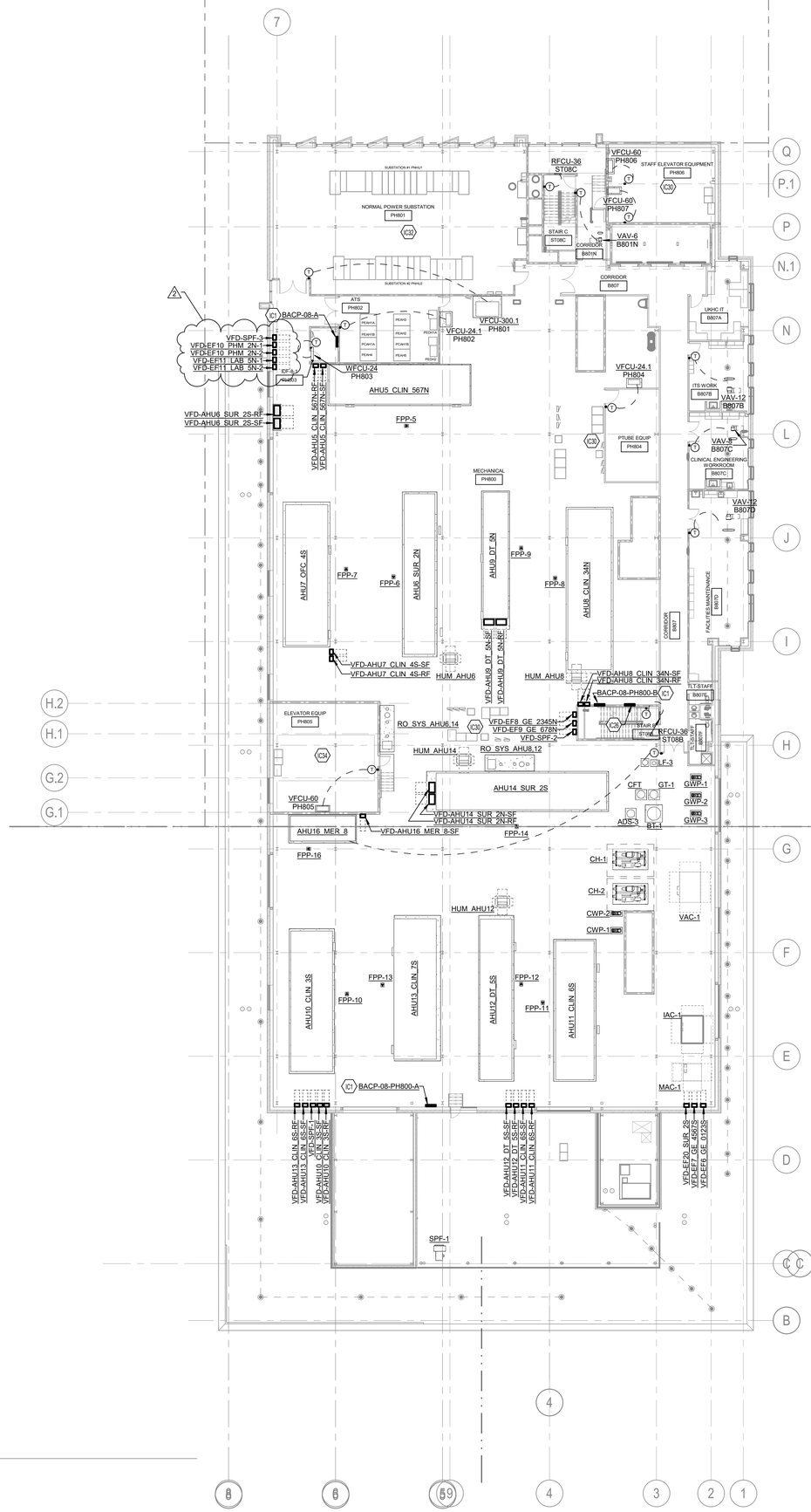
No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

DRAWING TITLE
MECHANICAL CONTROLS - LEVEL 07

SHEET NO.
IC107

10/1/2024 9:03:17 AM



TAGGED NOTES

2

- IC1 PROVIDE AND INSTALL NEW TIER 1 DDC CONTROL PANEL AND CABINET.
- IC26 ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL BUILDING LIGHTING CONTROLS PANEL. CONTROLS CONTRACTOR TO INTEGRATE BUILDING LIGHTING CONTROLS PANEL INTO BAS SYSTEM FOR TIMECLOCK CONTROLS.
- IC30 2 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
- IC32 4 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
- IC34 1 ENERGY METERS, CONTROLS CONTRACTOR TO INTEGRATE INTO BAS. COORDINATE WITH ELECTRICAL CONTRACTOR.

1 CONTROLS PLAN - LEVEL 08

SCALE: 1/16" = 1'-0"

0 4' 8' 16' 32' 48' 64'

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ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By	KAS
Checked By	SAC
Client Number	514
Project Number	6926

DRAWING TITLE

MECHANICAL CONTROLS - LEVEL 08

SHEET NO.

IC108

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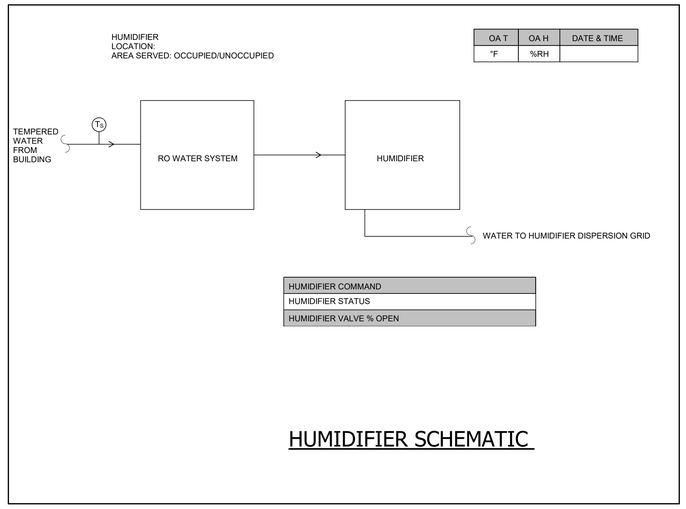


HUMIDIFIER SCHEMATIC

1. HUMIDIFIER

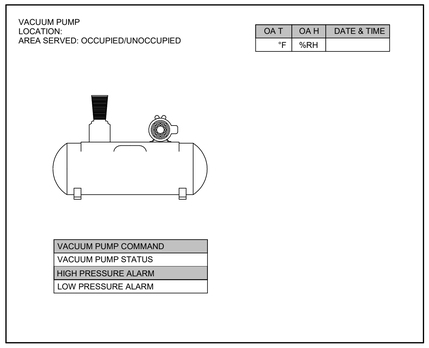
1.1. AHU1_DT_0S, AHU3_LAB_12N, AHU6_SUR_2S, AHU8_CLIN_34N, AHU12_DT_5S and AHU14_SUR_2N shall be provided a with an adiabatic humidifier. This shall be provided with a BACnet over MSTP communication and all points shall be available to the DDC system. The humidifier shall operate under its own controls to maintain 35% relative humidity in its associated space. The humidifier shall be enabled from the DDC system. When enabled from the DDC, the humidifier shall control the steam control valve. The valve shall be provided by the DDC contractor.

1.2 The humidifier shall be provided with a dedicated reverse-osmosis (RO) water treatment system. The RO system shall be provided with a monitoring system with BACnet over MSTP communication and all points shall be available to the DDC system.

1.3 Humidifier shall control humidity setpoint.

HUMIDIFIER SCHEMATIC

Point Description	Object Name	DI	DO	AI	AO	Override
Humidifier Command	HUM_C		X			X
Humidifier Status	HUM_S	X				
Humidifier Valve % Open	HUM_VLV_P			X		



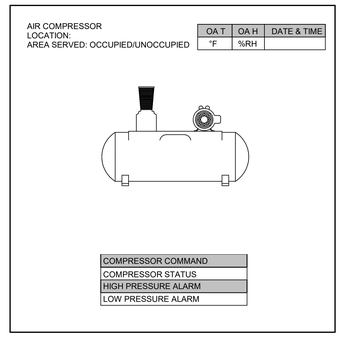
1. MEDICAL VACUUM PUMP

1.1. The meical vacuum pump (VAC-1) shall operate in a lead lag schedule. The DDC shall monitor both pumps.

1.2. The DDC system shall monitor the system pressure down stream of the dryer and provide a high and low pressure alarm.

MEDICAL VACUUM PUMP POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Vacuum Pump Command	VAC_C		X			X
Vacuum Pump Status	VAC_S	X				
High Pressure Alarm	VAC_HP_A	X				
Low Pressure Alarm	OA_F	X				



1. AIR COMPRESSOR

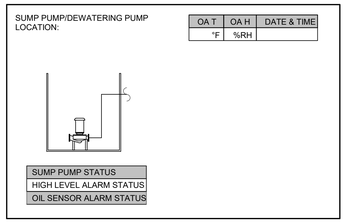
1.1. The medical air comressor (MAC-1) is a duplex air compressor and shall operate in a lead lag schedule. The air compressor shall have BACNET interface. The DDC system shall monitor both compressors. The compressor will alternate via the mechanical altenuator provided with the compressor.

1.2. The instrument air comressor (IAC-1) is a duplex air compressor and shall operate in a lead lag schedule. The air compressor shall have BACNET interface. The DDC system shall monitor both compressors. The compressor will alternate via the mechanical altenuator provided with the compressor.

1.3. The DDC system shall monitor the system pressure downstream of the dryer and shall provide a high or low pressure alarm.

MEDICAL VACUUM PUMP POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
MAC-1 Command	MAC_C		X			X
MAC-1 Status	MAC_S	X				
MAC-1 High Pressure Alarm	MAC_HP_A	X				
MAC-1 Low Pressure Alarm	MAC_LP_A	X				
IAC-1 Command	IAC_C		X			X
IAC-1 Status	IAC_S	X				
IAC-1 High Pressure Alarm	IAC_HP_A	X				
IAC-1 Low Pressure Alarm	IAC_LP_A	X				



1. ELEVATOR SUMP PUMP

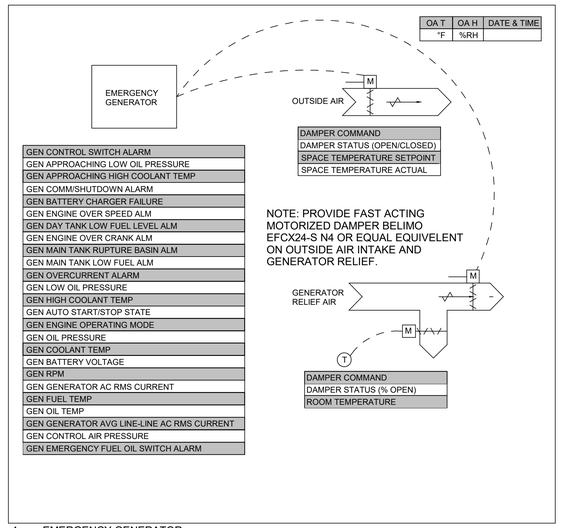
1.1. The DDC system shall monitor each building sump pump through the sump pump control panel. Provide all necessary equipment and labor to integrate the sump pump control panel into the BAS. Provide an alarm if the pump control panel is in an alarm status.

1.2. If high liquid levels are detected an alarm shall be signaled to the BAS.

1.3. If oil sensor is indicated an alrm shall be signaled to the BAS.

ELEVATOR SUMP PUMP POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Sump Pump Status	SP_X_S	X				
High Level Alarm	SP_XHL_A	X				
Oil Sensor Alarm	MAC_XO_A	X				



AHU-9 POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
GEN Control Switch Alarm	GEN_CS_A	X				
GEN Approaching Low Oil Pressure	GEN_ALOP_A			X		
GEN Approaching High Coolant Temp	GEN_AHCT_A			X		
GEN Comm/Shutdown Alarm	GEN_C/S_A	X				
GEN Battery Charger Failure	GEN_BCF_A	X				
GEN Engine Over Spreed Alarm	GEN_SPD_A	X				
GEN Day Tank Low Fuel Level Alarm	GEN_DT_LF_A			X		
GEN Engine Over Crank Alarm	GEN_ENG_OC_A	X				
Gen Main Tank Low Fuel Alarm	GEN_MT_LF_A			X		
GEN Overcurrent Alarm	GEN_OC_A	X				
GEN Low Oil Pressure	GEN_LOP_A	X				
GEN High Coolant Temp	GEN_HCT_A	X				
GEN Auto Start/Stop State	GEN_AUTO_S	X				
GEN Engine Operating Mode	GEN_ENG_OM		X			X
GEN Oil Pressure	GEN_OP_S			X		
GEN Coolant Temp	GEN_C_T			X		
GEN Battery Voltage	GEN_BT_V			X		
GEN RPM	GEN_RPM			X		
GEN Generator AC RMS Current	GEN_AC_C			X		
GEN Fuel Temp	GEN_F_T			X		
GEN Oil Temp	GEN_O_T			X		
GEN Generator Avg Line-Line AC RMS Current	GEN_LL_AC_C			X		
GEN Control Air Pressure	GEN_AP_C			X		
GEN Emergency Fuel Oil Switch Alarm	GEN_E_F_A	X				
OA Damper Command	OA_D_C		X			X
OA Damper Status	OA_D_S	X				
RA Damper Command	RA_D_C		X			X
RA Damper Status	RA_D_S	X				
Space Temp Set Point	SP_T_SP				X	X
Space Temp Actual	SP_T_A			X		

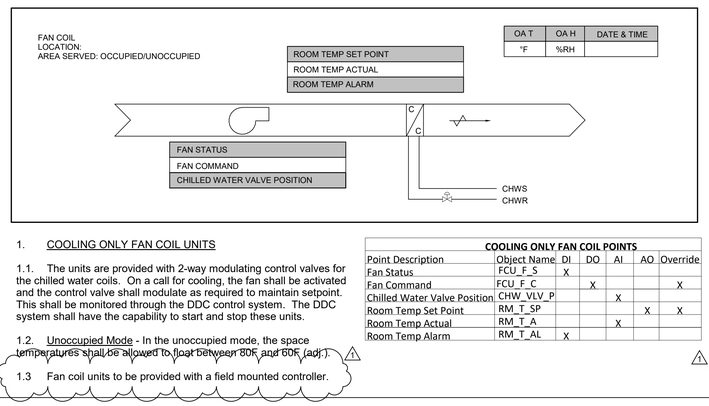
1. EMERGENCY GENERATOR

1.1. This building is equipped with 3 emergency generators.

1.1. The DDC shall monitor the status of each generator as well as low fuel level in the generator and is located on the loading dock. The (3) automatic transfer switches shall have their status monitored as well. The emergency generator shall be able to communicate to the DDC system via BACnet over MSTP and all points shall be available to the DDC system.

1.2. The Generator Equipment room shall be provided with two motorized damper fast open outside air intake damper on each outside air intake louver. The controls contractor shall provide the fast-open acutator, along with all required wiring and equipment. This dampers shall be normally closed and fail open. Upon initiation of any of the three generators, the DDC system shall open the intake dampers instantaneously to provide proper intake air to cool the generator.

1.3. Each generator shall be provided with a heat rejection duct routed to the building exterior. The heat rejection duct shall be provided with a branch duct and motorized damper that supplies directly into the space. This damper shall be normally closed and fail open. When the room temperature drops below 35 F (adj.) the motorized damper shall modulate open to bypass warm generator heat rejection air into the space to provide space heating. When the room temperature is above 35 F (adj.) this damper shall be closed.



1. COOLING ONLY FAN COIL UNITS

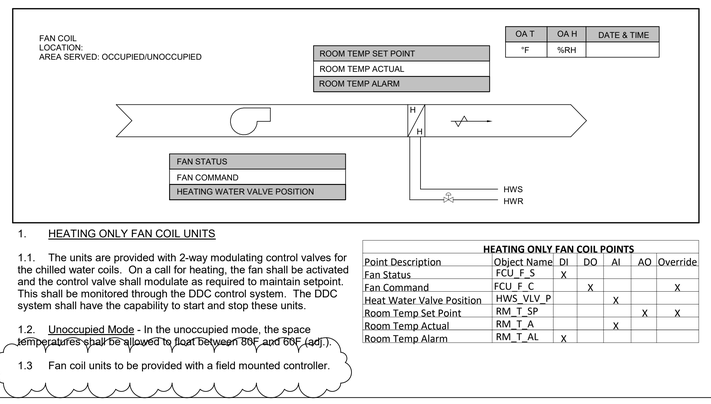
1.1. The units are provided with 2-way modulating control valves for the chilled water coils. On a call for cooling, the fan shall be activated and the control valve shall modulate as required to maintain setpoint. This shall be monitored through the DDC control system. The DDC system shall have the capability to start and stop these units.

1.2. Unoccupied Mode - In the unoccupied mode, the space temperatures shall be allowed to float between 80F and 60F (adj.).

1.3 Fan coil units to be provided with a field mounted controller.

COOLING ONLY FAN COIL POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Fan Status	FCU_F_S	X				
Fan Command	FCU_F_C		X			X
Chilled Water Valve Position	CHW_VLV_P			X		
Room Temp Set Point	RM_T_SP				X	X
Room Temp Actual	RM_T_A			X		
Room Temp Alarm	RM_T_AL	X				



1. HEATING ONLY FAN COIL UNITS

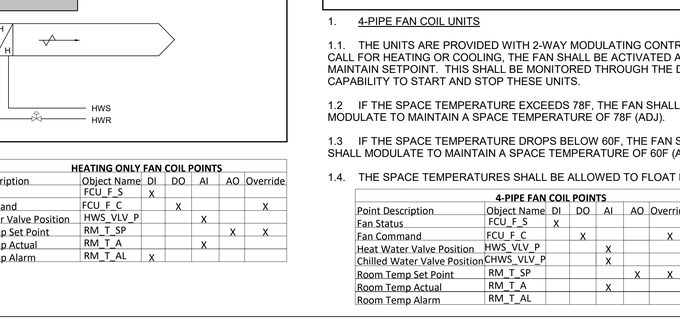
1.1. The units are provided with 2-way modulating control valves for the chilled water coils. On a call for heating, the fan shall be activated and the control valve shall modulate as required to maintain setpoint. This shall be monitored through the DDC control system. The DDC system shall have the capability to start and stop these units.

1.2. Unoccupied Mode - In the unoccupied mode, the space temperatures shall be allowed to float between 80F and 60F (adj.).

1.3 Fan coil units to be provided with a field mounted controller.

HEATING ONLY FAN COIL POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Fan Status	FCU_F_S	X				
Fan Command	FCU_F_C		X			X
Heat Water Valve Position	HWS_VLV_P			X		
Room Temp Set Point	RM_T_SP				X	X
Room Temp Actual	RM_T_A			X		
Room Temp Alarm	RM_T_AL	X				



1. DOMESTIC WATER BOOSTER PUMP

1.1. The domestic water booster pump shall operate under its own controls to maintain appropriate system pressure in the occupied mode. In the unoccupied mode, the system shall be off. The DDC system shall monitor pump status and provide an alarm if the pump is not operating in the occupied mode. The DDC system shall monitor the pressure set point and corresponding system pressure.

DOMESTIC WATER BOOSTER PUMP POINTS

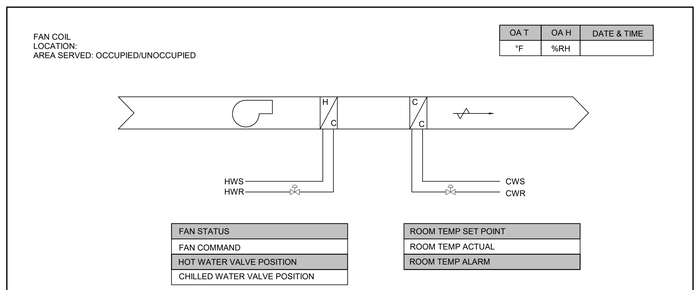
Point Description	Object Name	DI	DO	AI	AO	Override
DBP-1A Command	DBP_1A_C		X			X
DBP-1A Status	DBP_1A_S	X				
DBP-1A Speed	DBP_1A_SPD			X		
DBP-1B Command	DBP_1A_C		X			X
DBP-1B Status	DBP_1B_S	X				
DBP-1B Speed	DBP_1B_SPD			X		
Pressure Set Point	DCW_P_SP				X	X
Pressure Actual	DCW_P_A			X		

1. BUILDING FIRE PUMP

1.1. The DDC system shall monitor the building fire pump. Provide an alarm if the pump is in operation.

FIRE PUMP POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Fire Pump Status	FP_S	X				



1. 4-PIPE FAN COIL UNITS

1.1. THE UNITS ARE PROVIDED WITH 2-WAY MODULATING CONTROL VALVES FOR THE CHILLED AND HOT WATER COILS. ON A CALL FOR HEATING OR COOLING, THE FAN SHALL BE ACTIVATED AND THE CONTROL VALVE SHALL MODULATE AS REQUIRED TO MAINTAIN SETPOINT. THIS SHALL BE MONITORED THROUGH THE DDC CONTROL SYSTEM. THE DDC SYSTEM SHALL HAVE THE CAPABILITY TO START AND STOP THESE UNITS.

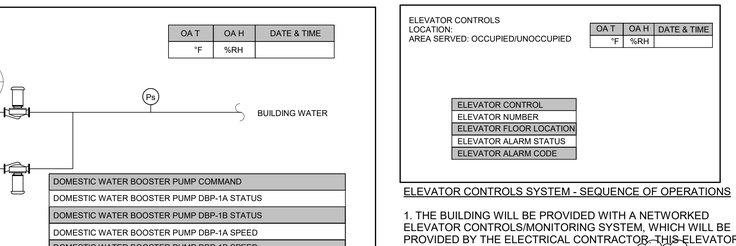
1.2 IF THE SPACE TEMPERATURE EXCEEDS 78F, THE FAN SHALL ACTIVATE AND THE CHILLED WATER CONTROL VALVE SHALL MODULATE TO MAINTAIN A SPACE TEMPERATURE OF 78F (ADJ.).

1.3 IF THE SPACE TEMPERATURE DROPS BELOW 60F, THE FAN SHALL ACTIVATE AND THE HEATING WATER CONTROL VALVE SHALL MODULATE TO MAINTAIN A SPACE TEMPERATURE OF 60F (ADJ.).

1.4. THE SPACE TEMPERATURES SHALL BE ALLOWED TO FLOAT BETWEEN 78F AND 60F (ADJ.).

4-PIPE FAN COIL POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Fan Status	FCU_F_S	X				
Fan Command	FCU_F_C		X			X
Heat Water Valve Position	HWS_VLV_P			X		
Chilled Water Valve Position	CHWS_VLV_P			X		
Room Temp Set Point	RM_T_SP				X	X
Room Temp Actual	RM_T_A			X		
Room Temp Alarm	RM_T_AL					



ELEVATOR CONTROLS SYSTEM - SEQUENCE OF OPERATIONS

1. THE BUILDING WILL BE PROVIDED WITH A NETWORKED ELEVATOR CONTROLS/MONITORING SYSTEM, WHICH WILL BE PROVIDED BY THE ELECTRICAL CONTRACTOR. THIS ELEVATOR CONTROLS SYSTEM SHALL BE EQUIPPED WITH A BACNET INTERFACE FOR INTEGRATION INTO THE BAS VIA IP.

2. PROVIDE A FULL GRAPHIC MAP OF THE BUILDING INDICATING ELEVATOR LOCATIONS AND ALARM STATUS, INCLUDING THE CENTRAL ENERGY PLANT. THE ELEVATOR FLOOR LOCATION SHALL BE INDICATED GRAPHICALLY ON THE MAP. IF AN ELEVATOR IS IN ALARM STATUS, THIS ELEVATOR SHALL BE HIGHLIGHTED IN RED ON THE MAP.

3. ALL POINTS AVAILABLE FROM THE ELEVATOR CONTROL SYSTEM SHALL BE MADE AVAILABLE TO THE BAS.

ELEVATOR POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Elevator Control	ELEV_C		X			X
Elevator Number	ELEV_N			X		
Elevator Floor Location	ELEV_FL			X		
Elevator Alarm Status	ELEV_A	X				
Elevator Alarm Code	ELEV_AC	X				

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CARMAN LANDSCAPE ARCHITECTURE URBAN PLANNING CIVIL ENGINEERING
WALSH CONSULTING GROUP
bell engineering
CDM Smith
PIVOTAL lighting design
HEALTHCARE

Cancer Treatment Center + Advanced Ambulatory Center

1220 Elizabeth St.
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UK Project Number 2563.0

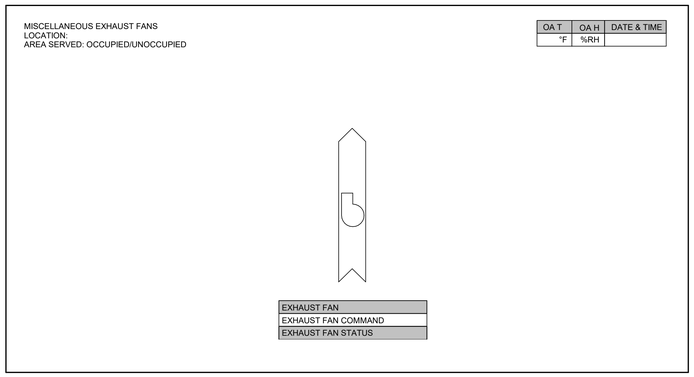
ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/18/24

Drawn By KAS
Checked By SAC
Client Number 514
Project Number 6926

DRAWING TITLE
MECHANICAL CONTROLS

SHEET NO.
IC208



1. MISCELLANEOUS EXHAUST FANS

1.1. EF2_HTE_05S and EF5_HTE_1N serves hot labs throughout the building. EF2_HTE_05S shall be provided with an ECM speed controller provided by the fan manufacturer. EF5_HTE_1N shall be provided with a VFD, VFD's shall be provided by the controls contractor. These fans shall operate 24/7 at a constant volume.

1.3. EF4_GEN_0N serves general exhaust spaces throughout the building. This fan shall be provided with a VFD, VFD's shall be provided by the controls contractor. This fan shall operate whenever AHU4_AUX_012N is in operation.

1.4. EF6_GE_0123S and EF8_GE_2345N serves general exhaust spaces throughout the building. These fans shall be provided with a VFD, VFD's shall be provided by the controls contractor. These fans shall operate 24/7 at a constant volume.

1.5. EF7_GE_4567S serves general exhaust spaces throughout the building. This fan shall be provided with a VFD, VFD's shall be provided by the controls contractor. This fan shall operate whenever AHU11_CLIN_6S is in operation.

1.6. EF9_GE_678N serves general exhaust spaces throughout the building. This fan shall be provided with a VFD. VFD's shall be provided by the controls contractor. This fan shall operate whenever AHU5_CLIN_567N is in operation.

1.7. EF13_ISO_1S and EF24_ISO_2N serve airborn infection isolation rooms. These fans shall be provided with an ECM speed controller provided by the fan manufacturer. These fans shall operate 24/7 at a constant volume.

1.8. EF14_RAD_0N serves the radioactive waste room on the lower level. This fan shall be provided with a VFD. VFD's shall be provided by the controls contractor. This fan shall operate 24/7 at a constant volume.

1.9. EF15_LAB_5N serves the stem cell lab. This fan shall be provided with an ECM speed controller provided by the fan manufacturer. This fan shall operate in response to a low oxygen signal reported to the BAS via oxygen depletion sensors located in the space. The controls contractor shall be responsible for providing and installing the oxygen depletion sensors. Refer to IC105 for oxygen depletion sensor locations.

1.10. EF16_MRI_1N, EF17_MRI_1N, EF18_MRI_1N and EF19_MRI_1N serve as emergency exhast fans for the MRI exam rooms on the first floor. These fans shall be provided with an ECM speed controller provided by the fan manufacturer. These fans shall be interlocked with there respective MRI and shall activate during a quench event at the associated MRI. Provide push button activation control for each fan in the locations indicated on the drawings. Activation of these fans shall generate an alarm at the DDC.

1.11. EF20_SUR_2S served the central sterile located on the second floor. This fan shall be provided with a VFD. VFD's shall be provided by the controls contractor. This fan shall operate 24/7 at a constant volume.

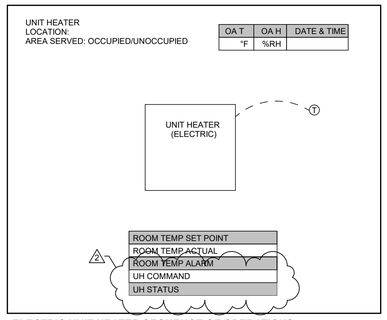
1.12. EF3_MED_0N, EF21_MED_2S and EF25_MED_2N serve medical gas storage rooms. EF21_MED_2S and EF25_MED_2N shall be provided with an ECM speed controller provided by the fan manufacturer. EF3_MED_0N shall be provided with a VFD, VFD's shall be provided by the controls contractor. These fans shall operate 24/7 at a constant volume.

1.13. EF22_LAB_0S serves an exhaust hood located in "A007B MOLD/BLOCK FABRICATION". This fan shall be provided with an ECM speed controller provided by the fan manufacturer. This fan shall operate 24/7 at a constant volume.

2.0. The DDC shall monitor the status of each of these fans listed via a current sensor. If the command does not match the fan status, then an alarm shall be generated to the BAS.

AHU-9 POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
EF2 Command	EF_F2_C		X			X
EF2 Status	EF_F2_S	X				
EF3 Command	EF_F3_C		X			X
EF3 Status	EF_F3_S	X				
EF4 Command	EF_F4_C		X			X
EF4 Status	EF_F4_S	X				
EF5 Command	EF_F5_C		X			X
EF5 Status	EF_F5_S	X				
EF6 Command	EF_F6_C		X			X
EF6 Status	EF_F6_S	X				
EF7 Command	EF_F7_C		X			X
EF7 Status	EF_F7_S	X				
EF8 Command	EF_F8_C		X			X
EF8 Status	EF_F8_S	X				
EF9 Command	EF_F9_C		X			X
EF9 Status	EF_F9_S	X				
EF13 Command	EF_F13_C		X			X
EF13 Status	EF_F16_S	X				
EF14 Command	EF_F14_C		X			X
EF14 Status	EF_F14_S	X				
EF15 Command	EF_F15_C		X			X
EF15 Status	EF_F15_S	X				
EF16 Command	EF_F16_C		X			X
EF16 Status	EF_F16_S	X				
EF17 Command	EF_F17_C		X			X
EF17 Status	EF_F17_S	X				
EF18 Command	EF_F18_C		X			X
EF18 Status	EF_F18_S	X				
EF19 Command	EF_F19_C		X			X
EF19 Status	EF_F19_S	X				
EF20 Command	EF_F20_C		X			X
EF20 Status	EF_F20_S	X				
EF21 Command	EF_F21_C		X			X
EF21 Status	EF_F21_S	X				
EF22 Command	EF_F22_C		X			X
EF22 Status	EF_F22_S	X				
EF24 Command	EF_F24_C		X			X
EF24 Status	EF_F24_S	X				
EF25 Command	EF_F25_C		X			X
EF25 Status	EF_F25_S	X				

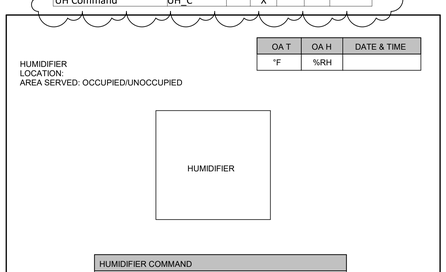


ELECTRIC UNIT HEATER SEQUENCE OF OPERATIONS

1.1. THE UNITS SHALL OPERATE UNDER THEIR OWN INTERNAL CONTROLS TO MAINTAIN SPACE TEMPERATURE. SPACE TEMPERATURE SHALL BE MONITORED THROUGH THE DDC CONTROL SYSTEM. THE DDC SYSTEM SHALL HAVE THE CAPABILITY TO START AND STOP THESE UNITS.

ELECTRIC UNIT HEATER POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Room Temp Set Point	RM_T_SP			X	X	
Room Temp Actual	RM_T_A			X		
RoomTemp Alarm	RM_T_AL Y	X				
UH Status	UH_S	X				
UH Command	UH_C		X			



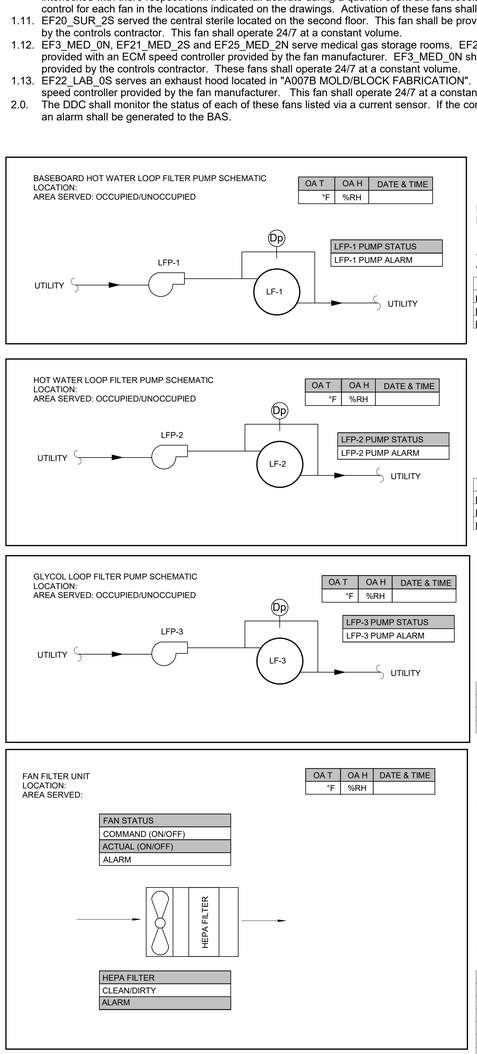
ELECTRIC HUMIDIFIER

1. ELECTRIC HUMIDIFIER

1.1. MRI VAV boxes shall be provided with a remote electric humidifiers (located in MRI equipment rooms) w/ duct mount dispersion. This shall be provided with a BACnet over MSTP communication and all points shall be available to the DDC system. The humidifier shall operate units its own controls to maintain appropriate humidity levels in the space served. The humidifiers shall be enabled from the DDC system. When enabled from the DDC, the humidifiers shall operate units its own controls sequence to maintain a minimum of 50% RH in the space.

ELECTRIC HUMIDIFIER POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Humidifier Command	HUM_C		X			X
Humidifier Status	HUM_S	X				
Humidifier Valve % Open	HUM_VLV_P			X		



1. BASEBOARD HOT WATER LOOP FILTER PUMP (LFP-1)

1.1. The Loop Filter Pump shall operate when the baseboard hot water pumps are in operation. LFP-1 shall be off when the baseboard hot water pumps are off.

1.2. The DDC shall monitor pumps status and sound an alarm if the pump is not operating at the same time as the baseboard hot water pumps.

LFP-1 POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
LFP-1 Pump Status	LFP_1P_S	X				
LFP-1 Pump Alarm	LFP_1P_A	X				

1. HOT WATER LOOP FILTER PUMP (LFP-2)

1.1. The Loop Filter Pump shall operate when the secondary hot water pumps are in operation. LFP-2 shall be off when the secondary hot water pumps are off.

1.2. The DDC shall monitor pumps status and sound an alarm if the pump is not operating at the same time as the secondary hot water pumps.

LFP-2 POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
LFP-2 Pump Status	LFP_1P_S	X				
LFP-2 Pump Alarm	LFP_1P_A	X				

1. GLYCOL LOOP FILTER PUMP (LFP-3)

1.1. The Loop Filter Pump shall operate when the secondary hot water pumps are in operation. LFP-3 shall be off when the secondary hot water pumps are off.

1.2. The DDC shall monitor pumps status and sound an alarm if the pump is not operating at the same time as the secondary hot water pumps.

LFP-3 POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
LFP-3 Pump Status	LFP_1P_S	X				
LFP-3 Pump Alarm	LFP_1P_A	X				

1. FAN FILTER UNITS (FFU)

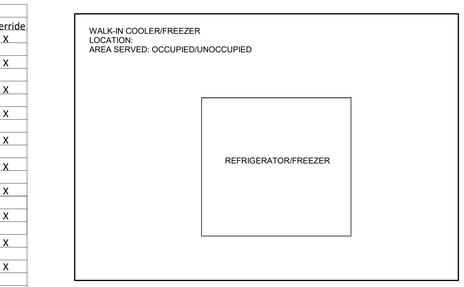
1.1. REFER TO DRAWINGS FOR LOCATIONS OF FAN FILTER UNITS. FAN FILTER UNITS SHALL BE CONSTANT VOLUME.

1.2. FAN FILTER UNITS SHALL OPERATE 100% OF THE TIME. THE BAS SHALL MONITOR THE STATUS OF THE FAN. IF THE FAN IS OFF AT ANY TIME, THE BAS SHALL GENERATE AN ALARM.

1.3 THE BAS SHALL MONITOR THE STATUS OF THE HEPA FILTER THROUGH THE FFU CONTROLS INTERFACE. THE BAS SHALL DISPLAY THE CLEAN/DIRTY STATUS OF THE HEPA FILTER. IF THE FFU OUTPUTS A DIRTY FILTER SIGNAL TO THE BAS, THEN THE BAS SHALL GENERATE AN ALARM.

FAN FILTER POINTS

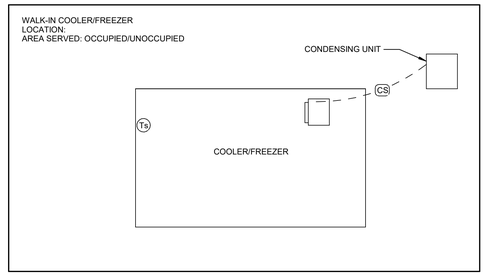
Point Description	Object Name	DI	DO	AI	AO	Override
Fan Command	FFU_F_C		X			X
Fan Actual	FFU_F_A	X				
Fan Alarm	FFU_F_AL	X				
HEPA Clean/Dirty	FFU_FL_C/D	X				
HEPA Alarm	FFU_FL_AL	X				



MEDICAL REFRIGERATOR/FREEZER - SEQUENCE OF OPERATIONS

1. The medical refrigerator/freezers included in the medical equipment drawings shall be provided with an integral temperature sensing suite. The controls contractor shall provide all equipment and wiring necessary to integrate this system into the BAS.

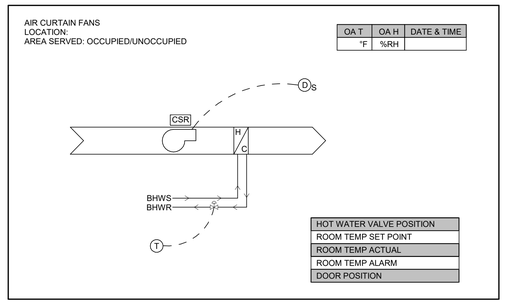
2. If the temperatures exceed a pre-designated setpoint (adj.), an alarm shall be generated to the BAS.



WALK-IN COOLER/FREEZER - SEQUENCE OF OPERATIONS

1. The controls contractor shall provide and install a wall-mounted temperature sensor inside each walk-in cooler/freezer and shall integrate into the BAS.

2. If the temperatures exceed a pre-designated setpoint (adj.), an alarm shall be generated to the BAS.



1. AIR CURTAIN FAN CONTROLS SEQUENCE

1.1. Air curtain fans shall be installed where indicated on the drawings.

1.2. When the door being served by the air curtain is closed, the air curtain shall remain off and the hot water control valve shall remain closed. When the door opens, the fan shall run and the hot water control valve shall open.

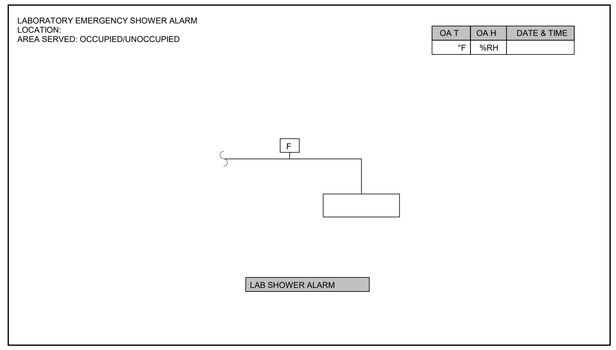
1.3. The air curtain heating coil shall be connected to the baseboard heating water system. The controls contractor shall provide a two-way two-position control valve installed on the baseboard heating water return pipe. The control valve shall be controlled by the same space thermostat as the VAV box serivng the space.

1.4. If no VAV box serves the space where the air curtain is installed, the temperature controls contractor shall provide a wall-mounted thermostat to control this valve.

1.5. When the space is in a call for heating, the control valve shall open fully to provide full coil flow for the air curtain fan heating coil. The air curtain supply fan shall be connected to a door switch and shall operate when the door is opened. The control valve position shall be monitored by the DDC system.

AIR CURTAIN POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Hot Water Valve Position	HWS_VLV_P			X		
Room Temp Set Point	RM_T_SP				X	X
Room Temp Actual	RM_T_A			X		
Room Temp Alarm	RM_T_AL	X				
Door Position	RM_D_P	X				



1. LABORATORY EMERGENCY SHOWER ALARM

1.1. Each laboratory emergency shower shall be provided with an auxiliary alarm that can be connected into the DDC system. The DDC system shall indicate an alarm anytime a shower has been activated.

LAB SHOWER POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Lab Shower Alarm	SHW_A	X				X

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PIVOTAL lighting design

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UK Project Number 2563.0

ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By KAS
Checked By SAC
Client Number 514
Project Number 6926

DRAWING TITLE

MECHANICAL CONTROLS

SHEET NO.

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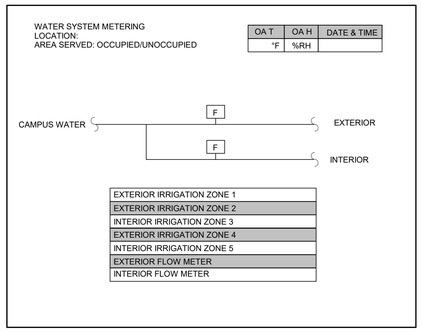
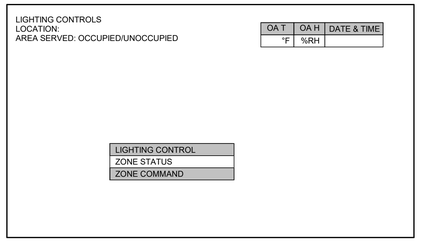


WATER SYSTEM METERING POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Exterior Zone 1 Flow	EZ_1_F			X		
Exterior Zone 2 Flow	EZ_2_F			X		
Exterior Zone 3 Flow	EZ_3_F			X		
Exterior Zone 4 Flow	EZ_4_F			X		
Exterior Zone 5 Flow	EZ_5_F			X		
Interior Zone 1 Flow	IZ_1_F			X		

1. WATER SYSTEM METERING

1.1. Provide a water meter for the buildings irrigation water loop which serves the yard hydrants and a separate loop which serves interior landscape areas. This shall be connected to the DDC system and provide a total GPM per month of water usage.



LIGHTING SYSTEM METERING POINTS

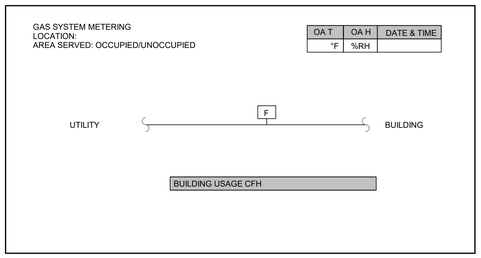
Point Description	Object Name	DI	DO	AI	AO	Override
Zone Status	LZ_X_S	X				
Zone Command	LZ_X_C		X			X

1. LIGHTING CONTROL SYSTEM

1.1. The DDC shall monitor the lighting control system both the interior and exterior lighting zones and shall have a visual indication on the graphics screen of the building if the lights are on or off for each room/area. The DDC system shall have the availability to turn on and off the lights and control all schedules at each of the following zones.

1.1. Number of control zones -

1.2. Provide all required relays, panels, controllers, etc. as required to control this system. Coordinate all requirements with lighting control vendor. Refer to electrical specifications for additional information.



1. BUILDING NATURAL GAS METERING - SEQUENCE OF OPERATIONS

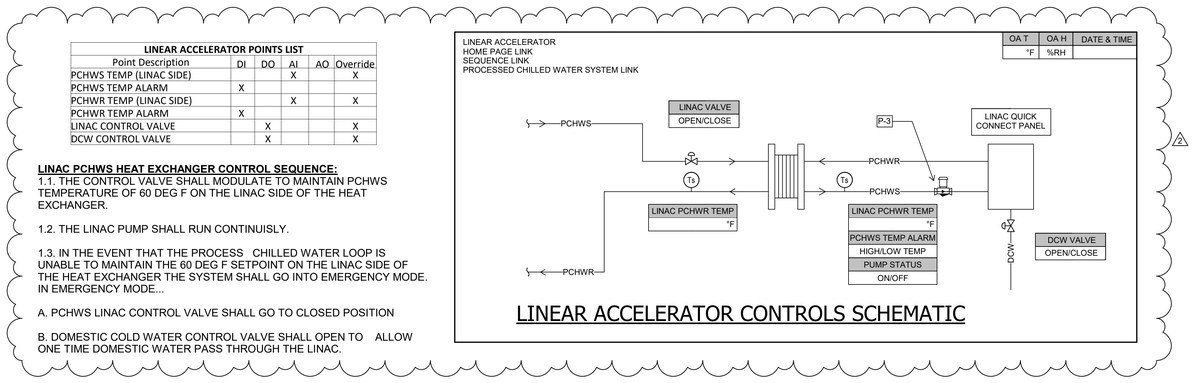
1.1. The controls contractor shall provide and install his digital gas meter in the main gas service entering the building. Coordinate size/requirements with the plumbing drawings. This meter shall be integrated into the BAS. All points available from the meter shall be made available to the BAS.

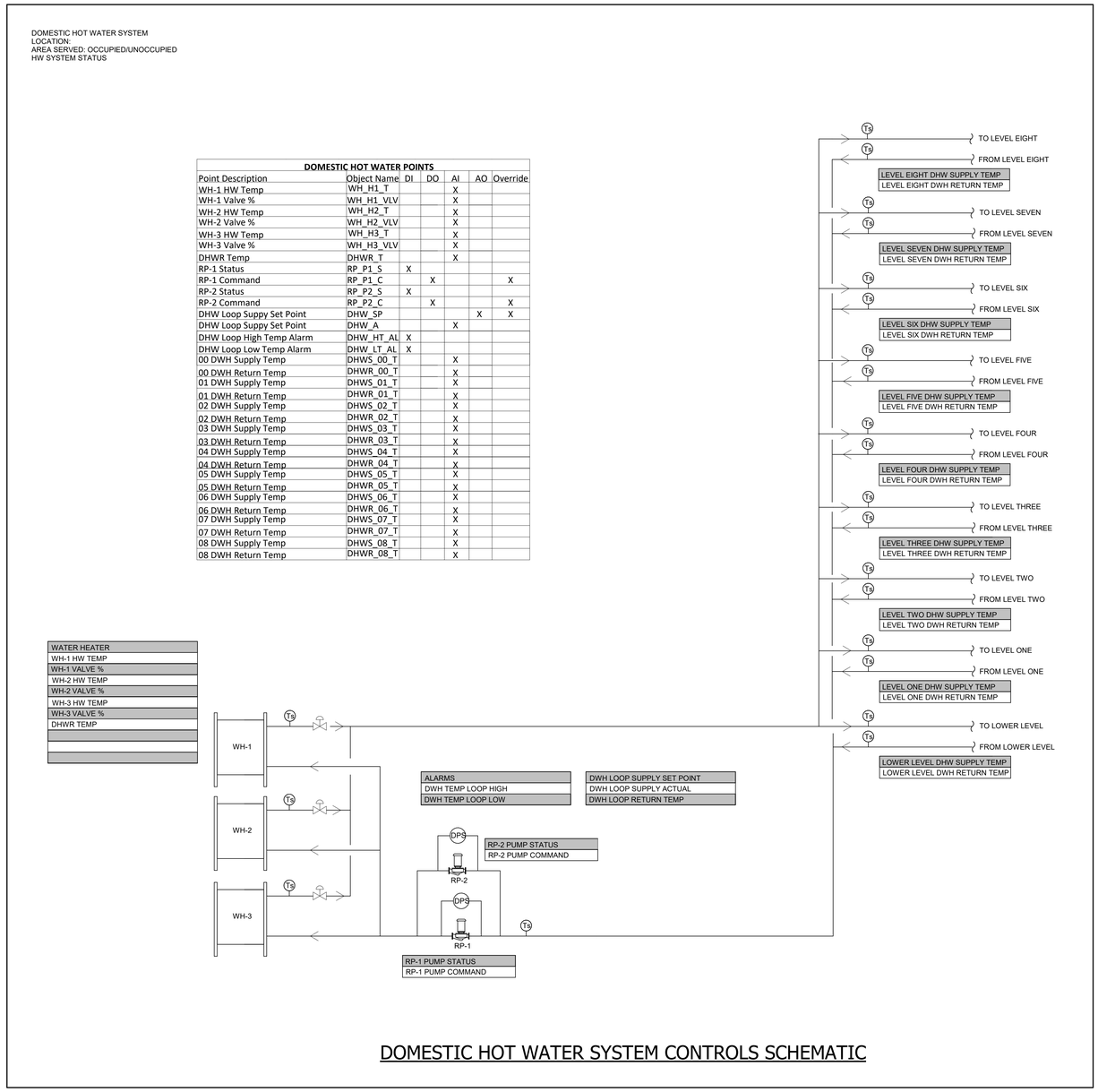
1.2. All controls wiring from the meter to the BAS shall be provided and installed by the TCC.

1.3. The provided meter shall have the capabilities of providing instanataneous consumption readings, as well as calculating consumption over a period of time, as indicated on the energy metering points list.

BUILDING NATURAL GAS METERING POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Building Usage	B_NG_U			X		





DOMESTIC HOT WATER POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
WH-1 HW Temp	WH_H1_T			X		
WH-1 Valve %	WH_H1_VLV			X		
WH-2 HW Temp	WH_H2_T			X		
WH-2 Valve %	WH_H2_VLV			X		
WH-3 HW Temp	WH_H3_T			X		
WH-3 Valve %	WH_H3_VLV			X		
DHWR Temp	DHWR_T			X		
RP-1 Status	RP_P1_S	X				
RP-1 Command	RP_P1_C		X			X
RP-2 Status	RP_P2_S	X				
RP-2 Command	RP_P2_C		X			X
DHW Loop Suppy Set Point	DHW_SP				X	X
DHW Loop Suppy Set Point	DHW_A			X		
DHW Loop High Temp Alarm	DHW_HT_AL	X				
DHW Loop Low Temp Alarm	DHW_LT_AL	X				
00 DWH Supply Temp	DHWS_00_T			X		
00 DWH Return Temp	DHWR_00_T			X		
01 DWH Supply Temp	DHWS_01_T			X		
01 DWH Return Temp	DHWR_01_T			X		
02 DWH Supply Temp	DHWS_02_T			X		
02 DWH Return Temp	DHWR_02_T			X		
03 DWH Supply Temp	DHWS_03_T			X		
03 DWH Return Temp	DHWR_03_T			X		
04 DWH Supply Temp	DHWS_04_T			X		
04 DWH Return Temp	DHWR_04_T			X		
05 DWH Supply Temp	DHWS_05_T			X		
05 DWH Return Temp	DHWR_05_T			X		
06 DWH Supply Temp	DHWS_06_T			X		
06 DWH Return Temp	DHWR_06_T			X		
07 DWH Supply Temp	DHWS_07_T			X		
07 DWH Return Temp	DHWR_07_T			X		
08 DWH Supply Temp	DHWS_08_T			X		
08 DWH Return Temp	DHWR_08_T			X		

1. DOMESTIC HOT WATER SYSTEM

1.1. The domestic hot water system shall run 24/7

1.2. The domestic hot water return pump RP-1 and RP-2 shall run constantly with one pump in standby. The lead pump shall regurarly cycle between RP-1 and RP-2

1.3. The deomestic hot water heaters WH-1, WH-2 and WH-3 shall run in a N+1 configuration with two water heaters operating in normal operation and one on standby. The water heaters shall control themselves through there own sequence to 125F water.

1.4 The DDC shall monitor the DHW supply and return temperature at each floor and report to the BAS.

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HEALTHCARE
Cancer Treatment Center + Advanced Ambulatory Center
1220 Elizabeth St.
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UK Project Number 2563.0

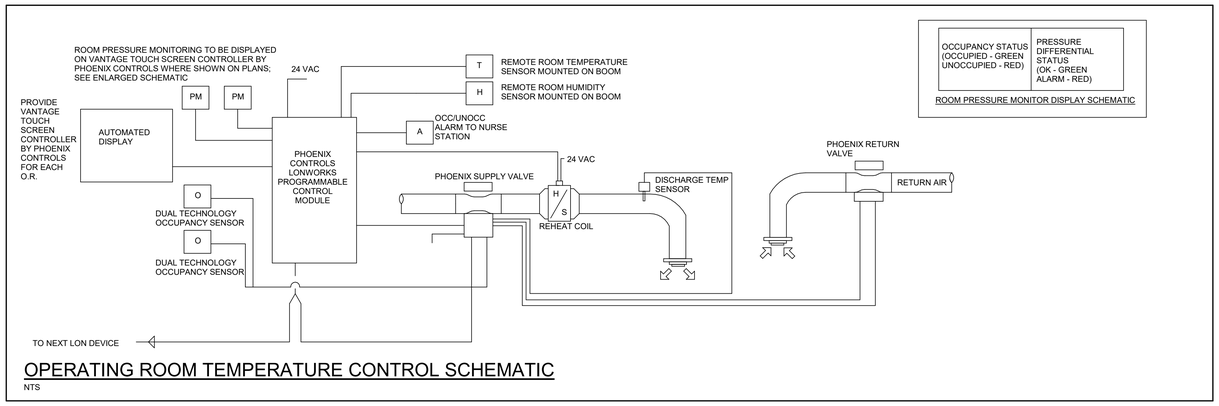
ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By: KAS
Checked By: SAC
Client Number: 514
Project Number: 6926

DRAWING TITLE: MECHANICAL CONTROLS

SHEET NO.: IC210



OPERATING ROOM TEMPERATURE CONTROL SCHEMATIC

NTS

SEQUENCE OF OPERATION- OPERATING ROOM TEMPERATURE AND PRESSURE CONTROL - PHOENIX CONTROL SYSTEM

THE FOLLOWING DESCRIBES THE SEQUENCE OF OPERATION FOR A TYPICAL OPERATING ROOM WITH VARIABLE AIR VOLUME VENTURI VALVES.

FLOW CONTROL

1. SUPPLY, RETURN AND EXHAUST VALVES SHALL PROVIDE PRESSURE INDEPENDENT CONTROL WHILE MAINTAINING THEIR FLOW SET POINTS TO (+-)5% ACCURACY.
2. A POSITIVE VOLUMETRIC OFF SET (ROOM DIFFERENTIAL) SHALL BE MAINTAINED BETWEEN THE OPERATING ROOM AND ADJOINING SPACES AT ALL TIMES. THE ROOM SHALL MAINTAIN AN OVERALL POSITIVE VOLUMETRIC OFFSET OF 500 CFM (ADJ.) IN OCCUPIED AND UNOCCUPIED MODES.

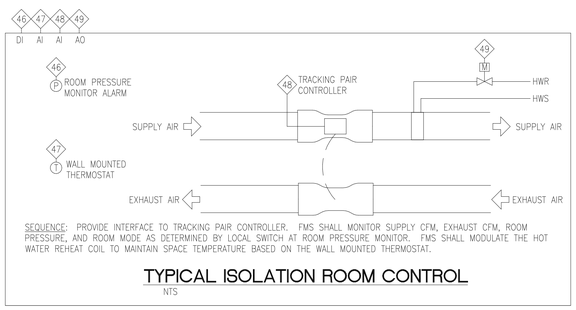
CLIMATE CONTROL

1. THE SUPPLY AIR VALVE SHALL OPERATE AT A CONSTANT VOLUME WHILE SPACE IS OCCUPIED. UPON A CALL FOR HEATING THE HOT WATER CONTROL VALVE SHALL MODULATES TO MAINTAIN SPACE SET POINT.
2. PROVIDE HUMIDITY MONITORING PERCENT RH FOR PROCEDURE.
3. THE CONTROL SYSTEM MONITORS DUCT DISCHARGE TEMPERATURE, ZONE TEMPERATURE, HOT WATER CONTROL VALVE, SUPPLY AND RETURN AIRFLOW RATES, OCCUPIED/UNOCCUPIED STATUS, AND RELATIVE HUMIDITY (RH ONLY AT LOCATIONS INDICATED). THESE VALUES SHALL BE DISPLAYED ON THE VANTAGE TOUCH SCREEN CONTROLLER INTERFACE.
4. ZONE SET POINTS ARE CAPABLE OF LOCAL OR REMOTE ADJUSTMENTS WITH THE CAPABILITY TO LOCKOUT LOCAL ADJUSTMENT.

OCCUPANCY

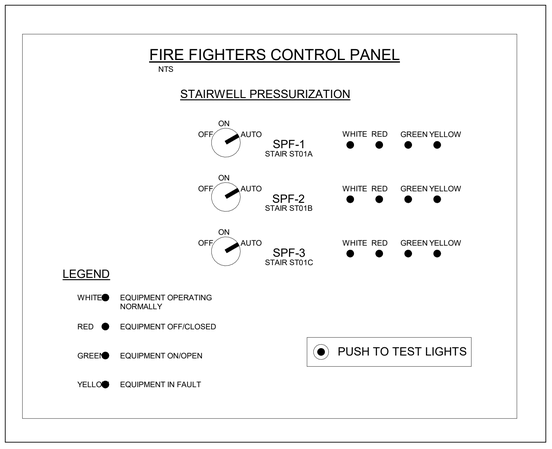
THE SYSTEM OPERATES THE AIR VALVES AND HEATING CONTROL VALVE IN AN OCCUPIED OR UNOCCUPIED MODE ACCORDING TO THE SPACE MOUNTED OCCUPANCY SENSORS, AND INCLUDES AN OVERRIDE AT THE ZONE THERMOSTAT OR AS DESCRIBED BELOW. THE CONTROLS CONTRACTOR SHALL PROVIDE AND INSTALL TWO CEILING-MOUNTED DUAL-TECHNOLOGY OCCUPANCY SENSORS. THE SYSTEM SHALL BE PLACED INTO UNOCCUPIED MODE WHEN THE SPACE HAS BEEN UNOCCUPIED FOR A PERIOD OF 30 MINUTES (ADJ.). THE SPACE SHOULD RETURN TO OCCUPIED MODE IMMEDIATELY WHEN OCCUPANCY IS SENSED.

- OCCUPIED MODE - THE SUPPLY AND RETURN AIR VALVES SHALL MAINTAIN THE OCCUPIED AIR VOLUME SHOWN IN THE SUPPLY AIR VALVE AND RETURN AIR VALVE SCHEDULES. UPON A CALL FOR HEATING, THE HOT WATER CONTROL VALVE SHALL MODULATE TO MAINTAIN SPACE SET POINT.
- UNOCCUPIED/SETBACK MODE - THE SYSTEM SHALL MODULATE THE SUPPLY AND RETURN AIR VALVES FROM MAXIMUM TO MINIMUM POSITIONS INDICATED ON THE SUPPLY AIR VALVE AND RETURN AIR VALVE SCHEDULES TO MAINTAIN THE OVERALL ROOM VOLUMETRIC OFFSET DESCRIBED HEREIN. THE HOT WATER CONTROL VALVE SHALL MODULATE AS NECESSARY TO MAINTAIN THE TEMPERATURE SETPOINT, AS DETERMINED BY THE OWNER.
- IN UNOCCUPIED MODE, THE OCCUPANCY SENSORS SHALL OVERRIDE THE SYSTEM INTO OCCUPIED MODE UPON NOTIFICATION OF OCCUPANCY FROM THESE SENSORS. PROVIDE A 30 MINUTE DELAY AFTER OCCUPANCY IS LAST REPORTED BY THE SENSORS BEFORE RETURNING THE SYSTEM INTO UNOCCUPIED MODE.



TYPICAL ISOLATION ROOM CONTROL

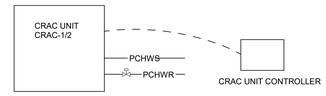
NTS



5 Fire Fighter Control Panel
SCALE: NONE

CRAC UNIT
LOCATION:
AREA SERVED: OCCUPIED/UNOCCUPIED

OA T	OA H	DATE & TIME
°F	%RH	



ROOM TEMP SET POINT
ROOM TEMP ACTUAL
CHILLED WATER VALVE POSITION
ROOM TEMP ALARM
CRAC UNIT STATUS

COMPUTER ROOM AC UNIT (CRAC) CONTROLS SCHEMATICS

1. COMPUTER ROOM AC UNIT CONTROLS SEQUENCE

1.1. These units shall be provided with factory controls capable of integrating into the BAS via BACnet over MSTP. The DDC system shall monitor space temperature and provide a high temperature alarm. Provide all necessary wiring conduit, etc. as required to interlock the DDC thermostat with unit and condensing unit. Units shall control to maintain all spaces served at a minimum of 72°F (adj.).

1.2. CRAC-1 and CRAC-2 is provided with an integral humidifier. The DDC system shall monitor space humidity and provide a low humidity alarm (<40% RH) and a high humidity alarm (>75% RH).

1.3. The DDC system shall have the ability to start and stop the split system. These shall be provided with a BACnet over MSTP communication and all points shall be available to the DDC system.

2

STAIRWELL PRESSURIZATION FANS
LOCATION:
AREA SERVED: OCCUPIED/UNOCCUPIED

OA T	OA H	DATE & TIME
°F	%RH	

STAIRWELL PRESSURIZATION FAN SPF-1, SPF-2, SPF-3
SPF-1 COMMAND
SPF-1 STATUS
SPF-1 ALARM
SPF-2 COMMAND
SPF-2 STATUS
SPF-2 ALARM
SPF-3 COMMAND
SPF-3 STATUS
SPF-3 ALARM

1. STAIRWELL PRESSURIZATION FANS

1.1. Upon an alarm activation signal from the fire alarm control panel, the stairwell pressurization fan shall enable and run constinuosly. If the command signal does not match the status and alarm shall be enuciated at the front end.

1.2. There shall be HOA switches located in the lower level fire command room to manually allow the starting of the stairwell pressurization fans.

1.3 All controls related to the stairwell pressuirization fans shall be UL864 listed. Provide all monitoring wiring from fans to fire fighter control panel located in the fire comman room on the lower level.

STAIRWELL PRESSURIZATION FAN POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
Fire Alarm Command	FAC_S	X				
SPF-1 Fan Status	SPF_F1_S	X				
SPF-1 Fan Command	SPF_F1_C		X			X
SPF-2 Fan Status	SPF_F2_S	X				
SPF-2 Fan Command	SPF_F2_C		X			X
SPF-3 Fan Status	SPF_F3_S	X				
SPF-3 Fan Command	SPF_F3_C		X			X

FUEL OIL PUMP
LOCATION:
AREA SERVED: OCCUPIED/UNOCCUPIED

OA T	OA H	DATE & TIME
°F	%RH	

FUEL OIL PUMP
FOP-1 COMMAND
FOP-1 STATUS

FUEL OIL PUMP POINTS

Point Description	Object Name	DI	DO	AI	AO	Override
FOP-1 Status	FOP_P1_S	X				
FOP-1 Fan Command	FOP_P1_C		X			X

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Drawn By KAS
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Client Number 514
Project Number 6926

DRAWING TITLE

MECHANICAL CONTROLS

SHEET NO.

IC212

VARIABLE FREQUENCY DRIVE SCHEDULE

MARK	MANUFACTURER	MODEL #	SERVICE	MOTOR HP	MOTOR AMPERAGE	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL HZ	FUSED AND DISCONNECT	BYPASS STARTER	REDUNDANT DRIVE W/ AUTOMATIC BYPASS	REMARKS
VFD-AHU1_DT_0S-RF	ABB	ACH580	AHU-1 RETURN FANS	40.00	52 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU1_DT_0S-SF	ABB	ACH580	AHU-1 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU2_DT_1S-RF	ABB	ACH580	AHU-2 RETURN FANS	25.00	34 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU2_DT_1S-SF	ABB	ACH580	AHU-2 SUPPLY FANS	75.00	96 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,114,15,16,17,18,19,20
VFD-AHU3_LAB_2N-RF	ABB	ACH580	AHU-3 RETURN FANS	40.00	52 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU3_LAB_2N-SF	ABB	ACH580	AHU-3 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU4_AUX_012N-RF	ABB	ACH580	AHU-4 RETURN FANS	30.00	44 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU4_AUX_012N-SF	ABB	ACH580	AHU-4 SUPPLY FANS	125.00	156 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU5_CLIN_567N-RF	ABB	ACH580	AHU-5 RETURN FANS	60.00	77 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU5_CLIN_567N-SF	ABB	ACH580	AHU-5 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU6_SUR_2S-RF	ABB	ACH580	AHU-6 RETURN FANS	30.00	44 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU6_SUR_2S-SF	ABB	ACH580	AHU-6 SUPPLY FANS	125.00	156 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU7_CLIN_4S-RF	ABB	ACH580	AHU-7 RETURN FANS	40.00	52 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU7_CLIN_4S-SF	ABB	ACH580	AHU-7 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU8_CLIN_34N-RF	ABB	ACH580	AHU-8 RETURN FANS	40.00	52 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU8_CLIN_34N-SF	ABB	ACH580	AHU-8 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU9_DT_5N-RF	ABB	ACH580	AHU-9 RETURN FANS	25.00	34 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU9_DT_5N-SF	ABB	ACH580	AHU-9 SUPPLY FANS	50.00	65 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU10_CLIN_3S-RF	ABB	ACH580	AHU-10 RETURN FANS	40.00	52 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU10_CLIN_3S-SF	ABB	ACH580	AHU-10 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU11_CLIN_6S-RF	ABB	ACH580	AHU-11 RETURN FANS	60.00	77 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU11_CLIN_6S-SF	ABB	ACH580	AHU-11 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU12_DT_5S-RF	ABB	ACH580	AHU-12 RETURN FANS	30.00	44 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU12_DT_5S-SF	ABB	ACH580	AHU-12 SUPPLY FANS	125.00	156 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU13_CLIN_6S-RF	ABB	ACH580	AHU-13 RETURN FANS	60.00	77 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU13_CLIN_6S-SF	ABB	ACH580	AHU-13 SUPPLY FANS	150.00	180 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU14_SUR_2N-RF	ABB	ACH580	AHU-14 RETURN FANS	60.00	77 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU14_SUR_2N-SF	ABB	ACH580	AHU-14 SUPPLY FANS	125.00	156 A	460 V	3	60	YES	NO	YES	1,2,3,4,5,6,13,14,15,16,17,18,19,20
VFD-AHU15_MER_02-SF	ABB	ACH580	AHU-15 SUPPLY FAN	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU16_MER_8-SF	ABB	ACH580	AHU-16 SUPPLY FAN	50.00	65 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU17_LOB_1S-RF	ABB	ACH580	AHU-17 RETURN FANS	25.00	34 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-AHU17_LOB_1S-SF	ABB	ACH580	AHU-17 SUPPLY FANS	125.00	156 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-BBP-1	ABB	ACH580	BBP-1	5.00	7 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-BBP-2	ABB	ACH580	BBP-2	5.00	7 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-CHPP-1	ABB	ACH580	CHPP-1	20.00	27 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-CHPP-2	ABB	ACH580	CHPP-2	20.00	27 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-CHPP-3	ABB	ACH580	CHPP-3	20.00	27 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-CHWP-1	ABB	ACH580	CHWP-1	75.00	96 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-CHWP-2	ABB	ACH580	CHWP-2	75.00	96 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-CHWP-3	ABB	ACH580	CHWP-3	75.00	96 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF3_MED_0N	ABB	ACH580	EF3_MED_0N	0.25		115 V	1	60	YES	YES	NO	ALL
VFD-EF4_GE_01N	ABB	ACH580	EF4_GE_01N	10.00		460 V	3	60	YES	YES	NO	ALL
VFD-EF5_HTE_1N	ABB	ACH580	EF5_HTE_1N	0.50		115 V	1	60	YES	YES	NO	ALL
VFD-EF6_GE_0123S	ABB	ACH580	EF6_GE_0123S	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF7_GE_4567S	ABB	ACH580	EF7_GE_4567S	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF8_GE_2345N	ABB	ACH580	EF8_GE_2345N	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF9_GE_678N	ABB	ACH580	EF9_GE_678N	5.00	7 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF10_PHM_2N-1	ABB	ACH580	EF10_PHM_2N	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF10_PHM_2N-2	ABB	ACH580	EF10_PHM_2N	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF11_LAB_5N-1	ABB	ACH580	EF11_LAB_5N	20.00	27 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF11_LAB_5N-2	ABB	ACH580	EF11_LAB_5N	20.00	27 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF14_RA_0N	ABB	ACH580	EF14_RAD_0N	1.00		115 V	1	60	YES	YES	NO	ALL
VFD-EF20_SUR_2S	ABB	ACH580	EF20_SUR_2S	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-EF28_GEN_1N	ABB	ACH580	EF28_GEN_1N	5.00	7 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HRCP-1	ABB	ACH550	HRCP-1	7.50	12 A	460 V	3	60	YES	NO	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HRCP-2	ABB	ACH550	HRCP-2	7.50	12 A	460 V	3	60	YES	NO	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HRCP-3	ABB	ACH580	HRCP-3	7.50	12 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HWP-1	ABB	ACH580	HWP-1	40.00	52 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HWP-2	ABB	ACH580	HWP-2	40.00	52 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HWP-3	ABB	ACH580	HWP-3	40.00	52 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HXP-1	ABB	ACH580	HXP-1	15.00	23 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-HXP-2	ABB	ACH580	HXP-2	15.00	23 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-SPF-1	ABB	ACH580	SPF-1	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-SPF-2	ABB	ACH580	SPF-2	10.00	14 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20
VFD-SPF-3	ABB	ACH580	SPF-3	15.00	23 A	460 V	3	60	YES	YES	NO	1,2,3,4,5,6,7,8,9,10,11,12,18,19,20

REMARKS:

1. AT MINIMUM, VFD SHALL INCLUDE 5% IMEDANCE VIA 5% AC LINE REACTOR OR DUAL DC BUS CHOKES SIZED TO 5% EQUIVALENT IMPENDANCE. VFD INPUT AMPS SHALL NOT EXCEED VFD OUTPUT AMPS.
2. PROVIDE UL1449 SURGE SUPPRESSION DEVICE.
3. VFD SHALL INCLUDE ALPHA-NUMERIC KEYPAD INERFACE, WITH DISPLAY IN PLAIN ENGLISH. (DISPLAYS RELYING SOLELY ON CODES ARE NOT ACCEPTABLE).
4. PROVIDE INTERNAL EMI/RFI FILTER PER IEC 61800-3.
5. VFD SHALL BE BTL LISTED FOR BACNET MS/TP, AND ALSO INCLUDE MODBUS AND N2.
6. VFD SHALL INCLUDE REAL TIME CLOCK WITH BATTERY BUCKUP (INLUDE 10 YEAR BATTERY).
7. PHASE LOSS PROTECTION & BROKEN BELT (LOSS OF LOAD) INDICATION WHILE IN BYPASS.
8. BYPASS CONTRACTORS SHALL BE POWERED BY SWITCH MODE POWER SUPPLY, ALLOWING +30% TO -30% INPUT VOLTAGE TOLERANCE. (120V CPT NOT ALLOWED).
9. VFD AND BYPASS SHALL BOTH INCLUDE BACNET MS/TP, DAMPER CONTROL AND FIREMAN'S OVERRIDE FUNCTIONALITY.
10. BYPASS OPERATION TO AUTO-RESET AFTER A BROWN OUT CONDITION.
11. INCLUDE FACST ACTION DRIVE ISOLATION FUSES.
12. BYPASS SHALL BE FULLY FUNCTIONAL IN THE EVENT OF A VFD FAILURE. BYPASS SHALL NOT RELAY ON THE VFD OR THE VFD'S CONTROL BOARD/RELAYS.
13. ABILITY FOR LOCAL OR REMOTE ALTERNATION. CONFIGURABLE FOR AUTOMATIC OR MANUAL TRANSFER UPON VFD FAULT.
14. BOTH VFDS MOUNTED IN COMMON ENCLOSURE. SINGLE MAIN DISCONNECTION MEANS. DRIVE ISOLATION FUSS FOR BOTH DRIVES.
15 INCLUDE A VFD1/ALTERNATION/VD2 SWITCH.
16. SINGLE POINT CONNECTION FOR RUN STATUS, FAULT STATUS, AND FOR DAMPER CONTROL AND FIREMAN'S OVERRIDE FUNCTIONALITY.
17. OUTPUT ISOLATION CONTRACTOR AFTER EACH VFD.
18. SYSTEM TO MEET IEEE 519-2014 BASE ON THE HARMONIC MITIGATION METHOD(S) IDENTIFIED IN THE ABOVE SCHEDULE.
19. VFD SELECTIONS ARE BASED ON MOTOR AMPERAGE NOT EXCLUSIVELY HORSE POWER.
20. VFDS'S ARE SHOWN FOR REFERENCE ONLY. VFD'S TO BE PROVIDED BY THE CONTROLS CONTRACTOR AS PART OF A FUTURE BID PACKAGE.

VENTURI VALVE SCHEDULE

MARK	MANUFACTURER	CONFIGURATION	SYSTEM	DUCT INLET	VALVE MINIMUM CAPACITY (CFM)	VALVE MAXIMUM CAPACITY (CFM)	MIN. INLET STATIC PRESSURE (" WC)	REMARKS
AVE-108	PHOENIX	SINGLE	EXHAUST	8"Ø	35	500	0.30	1,2,5
AVE-108	PHOENIX	SINGLE	EXHAUST	8"Ø	35	500	0.30	1,2,5
AVE-108	PHOENIX	SINGLE	EXHAUST	8"Ø	35	500	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-112	PHOENIX	SINGLE	EXHAUST	12"Ø	90	1050	0.30	1,2,5
AVE-114	PHOENIX	SINGLE	EXHAUST	14"Ø	200	1400	0.30	1,2,5
AVE-114	PHOENIX	SINGLE	EXHAUST	14"Ø	200	1400	0.30	1,2,5
AVE-114	PHOENIX	SINGLE	EXHAUST	14"Ø	200	1400	0.30	1,2,5
AVE-114	PHOENIX	SINGLE	EXHAUST	14"Ø	200	1400	0.30	1,2,5
AVE-114.B	PHOENIX	SINGLE	EXHAUST	14"Ø	0	1400	0.30	1,2,4,5
AVE-210	PHOENIX	DUAL	EXHAUST	10"Ø	100	1100	0.30	1,2,5
AVE-212	PHOENIX	DUAL	EXHAUST	12"Ø	180	2100	0.30	1,2,5
AVE-214	PHOENIX	DUAL	EXHAUST	14"Ø	400	2800	0.30	1,2,5
AVE-214	PHOENIX	DUAL	EXHAUST	14"Ø	400	2800	0.30	1,2,5
AVE-314	PHOENIX	TRIPLE	EXHAUST	14"Ø	600	4200	0.30	1,2,5
AVR-108	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,2,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-108.A	PHOENIX	SINGLE	RETURN	8"Ø	35	500	0.30	1,3,5
AVR-110.A	PHOENIX	SINGLE	RETURN	10"Ø	50	550	0.30	1,3,5
AVR-112	PHOENIX	SINGLE	RETURN	12"Ø	90	1000	0.30	1,2,5
AVR-114	PHOENIX	SINGLE	RETURN	14"Ø	200	1400	0.30	1,2,5
AVR-210.A	PHOENIX	DUAL	RETURN	10"Ø	100	1100	0.30	1,3,5
AVR-212	PHOENIX	DUAL	RETURN	12"Ø	180	2100	0.30	1,2,5
AVR-212	PHOENIX	DUAL	RETURN	12"Ø	180	2100	0.30	1,2,5
AVR-212.A	PHOENIX	DUAL	RETURN	12"Ø	180	2100	0.30	1,3,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-214	PHOENIX	DUAL	RETURN	14"Ø	400	2800	0.30	1,2,5
AVR-412	PHOENIX	QUAD	RETURN	12"Ø	600	4200	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,2,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-108.A	PHOENIX	SINGLE	SUPPLY	8"Ø	35	500	0.30	1,3,5
AVS-110	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,2,5
AVS-110	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,2,5
AVS-110	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,2,5
AVS-110	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,2,5
AVS-110.A	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,3,5
AVS-110.A	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,3,5
AVS-110.A	PHOENIX	SINGLE	SUPPLY	10"Ø	50	550	0.30	1,3,5
AVS-112	PHOENIX	SINGLE	SUPPLY	12"Ø	90	1050	0.30	1,2,5
AVS-112	PHOENIX	SINGLE	SUPPLY	12"Ø	90	1050	0.30	1,2,5
AVS-112	PHOENIX	SINGLE	SUPPLY	12"Ø	90	1050	0.30	1,2,5
AVS-112	PHOENIX	SINGLE	SUPPLY	12"Ø	90	1050	0.30	1,2,5
AVS-210	PHOENIX	DUAL	SUPPLY	10"Ø	100	1100	0.30	1,2,5
AVS-210.A	PHOENIX	DUAL	SUPPLY	10"Ø	100	1100	0.30	1,3,5
AVS-212	PHOENIX	DUAL	SUPPLY	12"Ø	180	2100	0.30	1,2,5
AVS-212	PHOENIX	DUAL	SUPPLY	12"Ø	180	2100	0.30	1,2,5
AVS-212	PHOENIX	DUAL	SUPPLY	12"Ø	180	2100	0.30	1,2,5
AVS-212	PHOENIX	DUAL	SUPPLY	12"Ø	180	2100	0.30	1,2,5
AVS-212	PHOENIX	DUAL	SUPPLY	12"Ø	180	2100	0.30	1,2,5
AVS-212.A	PHOENIX	DUAL	SUPPLY	12"Ø	180	2100	0.30	1,3,5
AVS-214	PHOENIX	DUAL	SUPPLY	14"Ø	400	2800	0.30	1,2,5
AVS-214	PHOENIX	DUAL	SUPPLY	14"Ø	400	2800	0.30	1,2,5
AVS-214	PHOENIX	DUAL	SUPPLY	14"Ø	400	2800	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-314	PHOENIX	TRIPLE	SUPPLY	14"Ø	600	4200	0.30	1,2,5
AVS-414	PHOENIX	QUAD	SUPPLY	14"Ø	800	5600	0.30	1,2,5
Grand total: 107								

REMARKS:

1. CONTRACTOR TO PROVIDE LOW PRESSURE VALVE.
2. VALVE ACTUATOR TO BE FAST ACTING.
3. VALVE ACTUATOR TO BE STANDARD ACTING.
4. VALVE TO BE POSITIVE SHUT-OFF VALVE.
5. CONTROLS CONTRACTOR TO PROVIDE VENTURI VALVE, MECHANICAL CONTRACTOR TO INSTALL.

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CARMAN LANDSCAPE ARCHITECTURE URBAN PLANNING CIVIL ENGINEERING
WALSH CONSULTING GROUP
bell engineering
CDM Smith
PIVOTAL lighting design

UK HEALTHCARE

Cancer Treatment Center + Advanced Ambulatory Center

1220 Elizabeth St.
Lexington, KY 40536

UK Project Number 2563.0

ISSUANCES

No.	Description	Date
1	CONTROLS RFP	06/16/24
2	CONTROLS ADDENDUM #1	09/30/24

Drawn By: KAS
Checked By: SAC
Client Number: 514
Project Number: 6926

DRAWING TITLE
MECHANICAL CONTROLS - SCHEDULES

SHEET NO.
IC300

HealthCare

CANCER TREATMENT CENTER & ADVANCED AMBULATORY CENTER

BID PACKAGE BP-07: BID & PERMIT

CORE & SHELL – GROUP 3

SEPTEMBER 23, 2024

UK Project No. 2563.0
HGA Commission No. 3776-003-00
Champlin Project No. 514-6926

HGA + CHAMPLIN ARCHITECTURE

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DIVISION 20 - MECHANICAL

DIVISION 21 – FIRE SUPPRESSION

DIVISION 22 – PLUMBING

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

END OF TABLE OF CONTENTS

SECTION 019113 - BUILDING SYSTEMS COMMISSIONING

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.

B. Specific Building Systems (MEP) Commissioning requirements are given in this specification. The following specification sections are related to the Commissioning work specified in this section:

1. Building Enclosure Commissioning requirements: refer to Section 019115.
2. Fire Suppression System requirements: refer to Division 21.
3. Plumbing System requirements: refer to Division 22.
4. Mechanical System requirements: refer to Division 20.
5. Test and Balance (TAB) requirements: refer to Section 203100.
6. HVAC System requirements: refer to Division 23.
7. Facility Management System (FMS) / Direct Digital Control (DDC) System requirements: refer to Division 25.
8. Electrical System Requirements: refer to Division 26.
9. Access Control and Video Surveillance System requirements: refer to Division 28.
10. Fire Alarm System requirements: Refer to Division 28.

1.2 SECTION INCLUDES

A. Section includes the Commissioning (Cx) requirements for the Building Fire Suppression, Mechanical, Plumbing, Heating Ventilating and Air Conditioning (HVAC), Electrical, and Electronic Safety and Security systems.

1. The Building Systems Commissioning requirements are separate from, and in addition to, the Building Enclosure Commissioning requirements in Section 019115. The Construction Manager and Subcontractors are required to participate in each of the Commissioning processes.
2. The 019113 Commissioning Agent (CxA) and 019115 Building Enclosure Commissioning Agent (BECxA) will provide separate documentation for each Commissioning process.

1.3 DESCRIPTION

A. Commissioning is a systematic process of ensuring all building systems perform interactively according to design intent and Owner’s operational needs. Commissioning will encompass and coordinate traditionally separate functions of system documentation, installation checkout, equipment Start-Up, control system calibration and point-to-point checkout, testing and balancing, and Functional Performance Testing. Commissioning is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify and document proper installation and performance of equipment and systems.

2. Provide Owner with functional buildings and/or systems with minimal operational problems at time of move-in.

B. Commissioning does not take away from or reduce responsibility of the Construction Manager or installing Contractors and Subcontractors to provide a finished and fully functioning product.

C. This section shall in no way diminish the responsibility of the Construction Manager, Contractors, Subcontractors and Suppliers in performing all aspects of work and testing as outlined in the contract documents. The Commissioning requirements in this specification are separate from and in addition to any other Equipment/Systems Testing, Demonstration or Commissioning requirements specified in other Sections of the Project Manual.

1.4 ABBREVIATIONS

A. The following are common abbreviations used in the Specifications (definitions are found further in this Section):

1. A/E - Architect and Design Engineers.
2. BECxA – Building Enclosure Commissioning Agent – refer to Section 01 91 15.
3. CM – Construction Manager.
4. Cx – Commissioning.
5. CxA - Commissioning Agent.
6. Cx Database – Commissioning Database.
7. Cx Plan - Commissioning Plan.
8. CxT - Commissioning Team.
9. DDC – Direct Digital Control.
10. FMS – Facility Management System / Direct Digital Control (DDC) System.
11. FMSC – Facility Management System Contractor
12. FPT - Functional Performance Test.
13. O&M - Operations & Maintenance.
14. OR - Owner’s Representative.
15. PFC - Pre-Functional Checklist.
16. RFI - Request for Information.
17. TAB - Test, Adjust and Balance.

1.5 DEFINITIONS

A. Acceptance Phase: Phase of construction after Start-Up and initial checkout when Functional Performance Tests, O&M documentation review and training occur.

B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to the Contract Documents.

C. Architect/Engineer (A/E): Prime consultant (architect) and sub-consultants who comprise the design team, generally HVAC Mechanical Designer/Engineer and Electrical Designer/Engineer.

D. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.

E. Building Enclosure Commissioning Agent (BECxA): Contracted to Owner. BECxA directs and coordinates day-to-day Building Enclosure Commissioning activities independently from CxA.

Refer to Section 019115 for Building Enclosure Commissioning Requirements. BECxA reports directly to Owner.

F. Commissioning Agent (CxA): Contracted to Owner. CxA directs and coordinates day-to-day Commissioning activities. CxA reports directly to Owner.

G. Commissioning (Cx) Database - A “cloud-based” process management platform provided by the CxA utilized to execute the Commissioning process.

H. Commissioning (Cx) Plan: Overall plan developed after bidding that provides structure, schedule and coordination planning for Commissioning process.

I. Contract Documents: Documents binding on parties involved in construction of this project (drawings, specifications, change orders, amendments, contracts, etc.).

J. Construction Manager: Contracted directly to Owner. Entity under contract to construct the project. May also be referred to as Contractor or General Contractor in other sections of the Project Manual.

K. Control System: System and components associated with Facility Management System (FMS) and/or Direct Digital Control (DDC) System. Refer to Division 25.

L. Commissioning (Cx) Database - A “cloud-based” process management platform provided by the CxA utilized to execute the Commissioning process.

M. Deferred Functional Tests: Functional tests performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow test from being performed.

N. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents (that is, does not perform properly or is not complying with design intent).

O. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions that fully describe system configuration and steps required to determine if the system is performing and functioning properly. These procedures shall be used to document Functional Performance Tests.

P. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with contract documents. Functional Performance Tests are executed after Pre-Functional Checklists and Start-Ups are complete.

Q. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of Facility Management Systems.

R. Overridden Value: Writing over a sensor value in DDC system to see response of a system (e.g., changing outside air temperature value from 52^{o}F to 72^{o}F to verify economizer operation). See also “Simulated Signal”.

S. Pre-Functional Checklist (PFC): A list of static inspections and elementary component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.).

T. Seasonal Performance Tests: Functional Performance Tests deferred until system(s) ambient conditions are closer to design conditions.

U. Simulated Condition: Condition created for testing component or system (e.g., applying heat to space temperature sensor to monitor response of VAV box).

V. Simulated Signal: Disconnecting sensor and using signal generator to send amperage, resistance or pressure to transducer and/or DDC system to simulate value to FMS.

W. Specifications: Construction specifications of Contract Documents.

X. Start-up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to Functional Performance Testing.

Y. Subcontractor: Contractors and their Subcontractors who provide and install building components and systems.

Z. Test Procedures: Step-by-step process, which must be executed to fulfill test requirements.

AA. Test Requirements: Requirements specifying what modes and functions, etc. will be tested. Test requirements are not detailed test procedures. Test requirements are specified in the Cx Plan.

BB. Trending: Monitoring using Facility Management System.

CC. Vendor: Supplier of equipment.

DD. Warranty Period: Warranty period for entire project, including equipment components.

1.6 COORDINATION

A. Commissioning Team: Members of the Commissioning Team (CxT) will consist of:

1. Commissioning Agent (CxA).
2. Owner’s Representative(s) (OR).
3. Representatives of the Facility User and Operation and Maintenance Personnel.
4. Architect and Design Engineers (A/E).
5. Construction Manager
6. The Contractors and Subcontractors who provide, install, or integrate with the equipment to be commissioned (e.g., Fire Alarm System Contractor integration with the HVAC equipment, etc.).
7. Test and Balance Contractor (TAB Contractor).
8. Facility Management System Contractor (FMSC).
9. Equipment Suppliers and Vendors.

B. Management: Owner will contract services of the CxA. The CxA directs and coordinates Commissioning activities and reports to OR. All members of the CxT shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.

C. Kick-Off Meeting: CxA will plan, schedule and conduct a Commissioning Kick-Off Meeting. Membership and responsibilities of the CxT will be clarified at this meeting. Cx Kick-Off Meeting shall be conducted no later than 30 days prior to initial installation of any commissioned equipment on-site (i.e., equipment set on site). CxA will distribute meeting minutes to all parties.

D. Scheduling:

1. CxA will work with Commissioning Team (CxT) to establish required Commissioning activities to incorporate in preliminary Commissioning schedule. The Construction Manager will integrate Commissioning activities into master construction schedule. Representatives of the CxT will address scheduling problems. Necessary notifications are to be made in a timely manner in order to expedite Commissioning.
2. The CxA will provide initial outline schedule of primary Commissioning events at Commissioning Kick-Off Meeting. As construction progresses, more detailed schedules are developed by the CxT.

E. Commissioning and Project Phasing:

1. Phased completion of the project construction is anticipated. The commissioning processes described herein will be completed for each phase of work.
2. All Commissioning work must be completed successfully with no remaining installation or operating deficiencies prior to Owner move-in/occupancy with the exception of the following:

a. Compilation and delivery of Final Commissioning Report.
b. Completion of Online Templates for project LEED Certification.
c. Compilation of LEED Current Facilities Requirements and Operations & Maintenance Plan (CFR and O&M Plan).
d. Compilation of LEED Systems Manual.
e. Compilation of LEED Ongoing Commissioning Plan.
f. Opposed Season Testing.
g. End of Warranty Review Meeting.

PART 2 - PRODUCTS / COMMISSIONING DOCUMENTATION

2.1 COMMISSIONING (CX) DATABASE

A. The Commissioning process will be executed utilizing a “cloud-based” Commissioning (Cx) Database provided by the CxA. The Cx Database is accessed by authorized users using any device running an HTML-5 internet browser (e.g., PC, laptop, tablet, phone) or by an operating system specific (e.g., iOS) application downloaded from corresponding app store.

B. CxA will provide the Construction Manager and Subcontractors with web access to the Cx Database during the Commissioning process to allow the Construction Manager and Subcontractors to complete the scoped Commissioning tasks indicated in other sections of this specification (e.g., completion of Commissioning activities such as notification of deficiency item corrections, readiness for Functional Performance Testing, etc.).

2.2 COMMISSIONING (CX) PLAN

A. CxA will develop overall plan for execution of the Commissioning Process. CxA will provide a single overall Commissioning Plan for all phases of work.

B. The Cx Plan will contain:

1. Executive Summary of overall commissioning process.
2. List of CxT members and roles and responsibilities.
3. Master Equipment List (list of commissioned equipment and systems).
4. Pre-Functional Checklists (PFCs) for commissioned equipment. The PFCs will be developed in the Cx Database.
5. Functional Performance Test Procedures for each commissioned equipment/system including integrated systems testing. The FPTs will be developed in the Cx Database. The initial Cx Plan will not include the FPTs; these will be developed once the FMS/DDC Submittal is approved by the A/E.
6. Sample Master Issues List (used to track issues/deficiencies throughout the commissioning process). The MIL will be developed in the Cx Database.
7. Operation and Maintenance (O&M) and Warranty Data Matrix documenting the O&M/Warranty Documentation requirements for commissioned equipment/systems.
8. Owner Training Matrix documenting the Owner Training requirements for commissioned equipment/systems.
9. Opposed Season Testing Matrix documenting the Opposed Season Testing requirements for commissioned equipment/systems.

C. The Cx Plan will be delivered to the CxT in electronic format (Adobe PDF file searchable from the Table of Contents).

2.3 COMMISSIONED EQUIPMENT/SYSTEMS SUBMITTALS AND O&M DATA

A. Construction Manager shall provide CxA with documentation required for Commissioning work. At minimum, documentation shall include: Requirements as described in Section 013300, detailed Start-Up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, duct pressure testing procedures and results, piping pressure testing and flushing procedures and results, FMS/DDC drawings, details of Owner contracted tests, Warranty Documentation, and Owner Training Documentation. In addition, installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians shall be submitted to CxA.

B. Construction Manager shall submit submittals for all commissioned equipment to CxA for review concurrently with A/E as required for LEED project certification.

C. Construction Manager shall submit one copy of the final A/E approved submittal data to the CxA for record purposes.

D. Construction Manager shall submit one copy of the final A/E approved O&M data for all commissioned equipment/systems to the CxA for record purposes.

E. Construction Manager shall submit one copy of as-built shop drawings of all FMS/DDC system including control sequences, control panels and components, master points list, etc., incorporating all field modifications made prior to Owner acceptance.

2.4 EQUIPMENT NAMEPLATE DOCUMENTATION

A. CM/Subcontractors shall submit photo documentation of the equipment nameplate information for all commissioned equipment (.jpg, .jpeg, .png, .tif, .tiff, format). Filenames shall be tagged by equipment identification from the Schedule drawings. The information shall be provided to the CxA prior to equipment installation.

B. CM/Subcontractors shall submit the following information to the CxA for each item of commissioned equipment. The information will be input by Construction Manager/Subcontractor into the Cx Master Equipment List spreadsheet (Microsoft Excel - .xls format) provided by the CxA. The information shall be provided to the CxA prior to equipment installation.

1. Equipment Manufacturer.
2. Equipment Model Number.
3. Equipment Serial Number.

2.5 SITE VISIT REPORTS

A. CxA will make periodic site visits to complete scoped commissioning work. CxA will provide a report for each site visit to members of the CxT.

B. CxA Site Visit Report will include the following:

1. Attendees and purpose of site visit.
2. Observations regarding commissioned systems and results of completed commissioning work.
3. “Next Steps” section documenting Cx process status and upcoming Cx work / site visits.
4. Current Master Issues List (MIL).
5. Status Report of Cx Process work completion.
6. Picture Report (where applicable).

2.6 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. The objective of the Pre-Functional Checklist is to verify and document that the equipment/systems are provided and installed according to documented design intent and Contract Documents.

B. CxA will develop the Pre-Functional Checklists from the Contract Documents and A/E approved Equipment Submittals. The Pre-Functional Checklists will be included in the Cx Plan developed in the Cx Database. The Pre-Functional Checklists will be completed during construction in the Cx Database by the CxA.

C. Sample Pre-Functional Checklists are included at the end of this specification. The samples are provided to give the Construction Manager and Subcontractors a general idea of the detailed installation items that will be checked for proper installation. The Pre-Functional Checklists included are prototypical, and do not reflect specific requirements of this project’s plans or specifications. Specific Pre-Functional Checklist items may be added, modified or deleted in the Construction Phase Cx Plan delivered to the CxT in order to reflect the final construction document requirements. Construction Manager and Subcontractors shall review final construction documentation for applicable details and specifications related to equipment to be commissioned in order to fully ascertain all of the Pre-Functional Checklist requirements.

2.7 START-UP PLAN

A. Construction Manager and Subcontractors responsible for purchase, installation and Start-Up of commissioned equipment shall compile all testing and equipment Start-Up documentation into an overall Start-Up Plan document.

B. Start-Up Plan shall include the following documentation:

1. Testing documentation and recording forms for all testing required by Division 20, 21, 22, 23, 26, and 28 specifications (e.g., duct pressure testing, duct cleaning, pipe pressure testing, piping flushing and cleaning plans, electrical testing, etc.). Testing documentation shall include:

    a. A written description of the required testing and the procedures required to complete the testing.
    b. All instrumentation utilized for the testing.
    c. Checklist with boxes or lines for recording and documenting the completion of the testing activity and results.

2. Equipment Start-Up Documentation including detailed Start-Up procedures from equipment manufacturer and checkout procedures with normally used field checkout sheets. Start-up documentation shall include checklists and procedures with specific boxes or lines for recording and documenting inspections of each piece of equipment.
3. Facility Management System Start-Up and initial check-out documentation and recording forms including but not limited to point-to-point verifications, control sensor calibrations, and control valve/damper actuator calibrations for inclusion in the Start-Up Plan. Facility Management System Start-up documentation shall include checklists and procedures with specific boxes or lines for recording and documenting inspections of each control system point, sensor or device.
4. Test and Balance (TAB) Execution Plan outlining the TAB procedures and proposed sequencing and scheduling of required TAB work.
5. Equipment Maintenance Log including a listing all maintenance tasks (including frequency of execution) required to be performed on equipment started to ensure equipment warranties are not voided. Start-Up Plan documentation shall include a log for each required maintenance task for Subcontractor/Vendor to document execution of the required maintenance tasks from Start-Up through Final Application for Payment.

C. Start-Up Plan documentation shall be provided in “searchable” electronic PDF format as follows:

1. Provide a separate Start-Up Plan PDF file for each Division of work (e.g., Division 20 Start-Up Plan Division 21 Start-Up Plan, Division 22 Start-Up Plan, Division 23 Start-Up Plan, etc.)
2. Each Start-Up Plan PDF file will have a Cover Sheet with Project Information and Document Title.
3. Each Start-Up Plan PDF file will have a Table of Contents. The Table of Contents shall be “bookmarked” for hyperlink navigation directly to each section and item/document noted below.

    a. Proposed Schedule/Sequencing Plan of Testing and Start-Up activities.
    b. Completed Testing documentation (e.g., duct pressure testing, duct cleaning, piping pressure testing, piping flushing and cleaning, electrical testing, etc.) organized by specification section.
    c. Executed Start-Up Checklists for each item of equipment organized by specification section.

d. Completed Facility Management System Start-Up activities completed by the Facility Management System Contractor including but not limited to all point-to-point verifications, control sensor calibrations and control actuator calibrations.
e. TAB Execution Plan.
f. Warranty Maintenance Log for each item of equipment organized by specification section.

2.8 OWNER TRAINING

A. Construction Manager with assistance from responsible Subcontractors and Equipment Vendors will provide Owner training in Start-Up, Operation and Maintenance of all commissioned systems/equipment under contract per Project Manual specifications.

2.9 FACILITY MANGEMENT SYSTEM (FMS) TREND DATA

A. Building Systems operation will be monitored and analyzed by the CxA utilizing trend data provided from the FMS.

B. The Facility Management System Contractor (FMSC) for this project shall provide trend data for all commissioned equipment/systems monitored or controlled by the FMS. The complete cost for the FMSC to set up all required trending and reporting shall be included in the project contract cost.

C. Examples of FMS trended points by system type utilized for commissioning are included in a Table at the end of this specification. The CxA will conduct an FMS Cx Trend Data Planning Meeting with the FMSC as a part of the Cx FPT Scheduling Meeting. The FMS Cx Trend Data Planning Meeting will coordinate and finalize:

1. System points to be monitored.
2. Frequency/interval of monitoring for each point.
3. Trend data output file format, presentation, and data-transfer requirements.
4. Equipment/systems adjustments required for “forced” peak load trending (e.g., adjusting equipment space temperature sensor setpoints to simulate peak cooling/heating loads, utilizing AHU preheat coil to simulate peak cooling load, etc.).

D. Prior to the FMS Cx Trend Data Planning Meeting; the FMSC will provide CxA with a Master Point Summary Table, organized by equipment type, listing all FMS points for each item of equipment controlled or monitored by the FMS. The Master Point Summary Table shall list the following information:

1. Building Designator.
2. Building Name.
3. System Description or Equipment Name. Equipment Names shall match drawing Schedule information.
4. Point ID.
5. Point Type.
6. Full point name.
7. English language point description. The point description shall be an easily understandable English-language description of the point.
8. Node address (Domain, Subnet, Node).
9. Node/Device ID.
10. Device MAC Address, where applicable.

11. Object ID [object type, instance number] (BACnet Systems).
12. Engineering units.
13. Alarm limits, if any.

E. General Trend Report Requirements

1. Each trend report is generated in a Microsoft Excel-readable file format (e.g., .xlsx, .csv, or .txt).
2. Equipment/System Trend Reports shall be compiled in separate Workbooks for each equipment type or system.
3. Each Workbook shall be titled by specific equipment/system type (e.g., Air Handling Unit, VAV Box, Exhaust Fan, Chilled Water System, Heating Hot Water System, etc.). Max Workbook file size is 10MB. Provide multiple Workbook files (e.g., Air Handling Unit 1, Air Handling Unit 2, etc.) if required to meet file size limitations.
4. Each Workbook will contain separate Trend Data worksheets for each piece of equipment. Each worksheet will be tabbed by project specific equipment name per project schedule drawings.
5. Refer to Sample Trend Report at the end of this specification for required Worksheet Trend Report format/layout.
6. Cx FMS Trend Reports shall remain in place through the project one year warranty period (to allow CxA to utilize FMS Trend Reports for Opposed Season Testing and Warranty Review).

F. Trend Point Configuration

1. All data point names must be unique from other points in the same project.
2. Each trend data point shall record the instantaneous value of the corresponding control data point being trended at 5-minute, 15-minute, or change-of-value intervals. The trend sampling interval for each data point must be consistent (e.g., data cannot start at a 5-minute interval and then change to a 15-minute interval).
3. All utility consumption data (kWh, ton-hr., btu, etc.) trends shall report the accumulated consumption across the interval period (e.g., electrical consumption, kWh, total for the 15-minute period) and shall not report total accumulating consumption.
4. All utility demand data (kW, ton, btu/hr., etc.) trends shall report the instantaneous demand at a 15-minute interval period unless otherwise specified by the CxA and shall not report total accumulating demand.
5. Input a custom data point naming convention utilized for trend reports that shall comply with the Owner’s established point naming convention.

2.10 FUNCTIONAL PERFORMANCE TEST (FPT)

A. CxA will develop the Functional Performance Test (FPT) procedures from the Contract Documents and A/E approved FMS Control Submittal. The FPT procedures will be included in the Cx Plan developed in the Cx Database. The FPTs will be executed by the Construction Manager and Subcontractors. The CxA will witness the FPT and document the results in the Cx Database.

B. Development of Test Procedures:

1. The purpose of any given specific test is to verify and document compliance with stated criteria of acceptance given on test form. CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Contractors will provide limited assistance to CxA in developing procedure (i.e.,

answering questions about equipment, operation, sequences, etc.). Prior to execution, CxA shall provide a copy of test procedures to CxT for review. Construction Manager and Subcontractors will review tests for feasibility, safety and equipment warranty protection.

2. Test procedure forms developed by the CxA will include (but not be limited to) the following information:

   a. System and equipment or component name(s).
   b. Equipment location and ID number.
   c. Date.
   d. Project name.
   e. Participating parties.
   f. Specific sequence of operation or other specified parameters being verified.
   g. Instructions for setting up test.
   h. Specific step-by-step procedures to execute test, in a clear, sequential and repeatable format.
   i. A Yes/No checkbox to allow for clearly marking whether or not proper performance of each part of test was achieved.
   j. Section for comments

3. Sample Functional Performance Test (FPT) forms are included at the end of this specification. The samples are provided to give the Construction Manager and Subcontractors a general idea of the work required to complete the FPT. The FPT checklists included are prototypical, and do not reflect specific requirements of this project's plans or specification. Specific FPT items may be added, modified or deleted in the Cx plan delivered to the CxT in order to reflect the final construction document requirements. Construction Manager and Subcontractors shall review final construction documentation for applicable details and specifications related to equipment to be commissioned in order to fully ascertain all of the FPT requirements.

2.11 CXA MASTER ISSUES LIST (MIL)

A. Any issues noted by CxA are tracked in a Master Issues List (MIL) accessed from the Commissioning (Cx) Database.

2.12 TEST EQUIPMENT

A. Construction Manager and Subcontractors shall provide all specialized tools, test equipment and instruments required to execute Start-Up, checkout and Functional Performance Testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with tolerances specified. A testing laboratory shall have calibrated test equipment within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be calibrated according to manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

C. Construction Manager/Electrical Subcontractor shall provide full capacity Load Banks for Emergency Power System Testing. Full capacity Load Banks may be required during separate testing periods (three or more) depending on construction completion and equipment readiness for testing. Provide Load Banks for one week testing period for each system test to allow for potential weather events.

2.13 SYSTEMS MANUAL DOCUMENTATION

A. Construction Manager will provide the following documentation for each item of commissioned equipment and each commissioned system to the CxA for preparation of various electronic Systems Manuals. This documentation is in addition to any documentation required in other specification sections of the Project Manual:

1. Final Owner's Project Requirements Document (from Owner).
2. Final Basis of Design Document (from A/E).
3. Construction Record Drawings and Specifications.
4. As-Built Drawings.
5. A/E approved equipment submittals.
6. A/E approved Operations and Maintenance (O&M) Data including:

    a. Operating instructions for all equipment.
    b. Preventive maintenance plan for building equipment including recommended schedule and frequency for equipment preventative maintenance.

7. As-Built FMS/DDC Drawings/Schematics and Sequences of Operation including the following information for each commissioned system:

    a. Building Occupancy Schedule.
    b. Operating instructions for associated integrated building systems.
    c. Instructions for Energy Saving Operations and descriptions of Energy Savings Strategies in use in the facility.
    d. Seasonal Start-Up and shut down procedures, manual and restart operations procedures, recommendations regarding seasonal operational issues that affect energy use.
    e. A list of equipment run-time and time of day schedules (occupied/unoccupied) and a schedule frequency to review them for relevance and efficiency.
    f. Setpoints for all systems.

        1) Changes in schedules or setpoints for different seasons, days of the week, and times of day.
        2) A table of all user adjustable set points and reset schedules with a brief discussion of the purpose of each and the range of reasonable adjustments with energy implications. Include a schedule of frequency to review the various set points and reset schedules to ensure they are at current relevant and efficient values.

    g. Any ongoing system optimization procedures.
    h. A table of all sensors and actuators including a recommendation for recalibration frequency of each sensor and actuator by type and use.

8. Owner Training Documentation.

B. Documentation shall be provided in "searchable" "bookmarked" electronic Adobe PDF format organized as follows:

1. Separate Adobe PDF file for:

    a. Final Owner's Project Requirement Document
    b. Final Basis of Design Document.

c. Construction Record Drawings and Specifications bookmarked by drawing number and specification Section/Title.
d. As-Built Drawings bookmarked by drawing number.
e. Equipment Submittals bookmarked by specification Section/Title.
f. Equipment O&M Data bookmarked by equipment specification Section/Title.
g. As Built FMS/DDC drawings bookmarked by system.
h. Owner Training Documentation bookmarked by specification Section/Title.

2. Table of Contents for each PDF document organized by contract document specification Section and specific contract document identification tag. The Table of Contents shall by hyperlinked to allow direct access from each Section to each individual equipment item and each specific information item for the equipment.

2.14 FINAL COMMISSIONING REPORT

A. The Final Commissioning Report will include:

1. Executive Summary including:

a. List of Commissioned Equipment/Systems.
b. List of participants and roles.
c. Overview of Commissioning and testing scope and general description of testing and verification methods.
d. Evaluation regarding disposition of equipment, systems and documentation in the following areas:

1) Conformance to specifications and design intent.
2) Equipment installation.
3) Functional performance.
4) Recommendations for improvement to equipment or operations, future actions, etc. will also be listed.

2. Master Issues List.
3. Executed Pre-Functional Checklists.
4. Executed Functional Performance Tests.
5. Site Visit Reports.
6. Design Phase Cx Documentation.
7. Executed Matrices documenting Cx verification of O&M, Warranty and Owner Training for commissioned equipment/systems.
8. Sections will be provided for the following information to be inserted at a later date:

a. Opposed Season Testing.
b. End of Warranty Review Meeting Minutes.

PART 3 - EXECUTION

3.1 COMMISSIONING OVERVIEW

A. The following provides a brief overview of typical Commissioning tasks during construction and general order in which they occur:

1. CxA develops project specific Commissioning Plan in the Cx Database including specific Pre-Functional Checklists and equipment and system Functional Performance Test procedures. CxT members are provided web access to the Cx Database for review of the Cx Plan prior to Cx Kick-Off meeting.
2. Commissioning during construction begins with a Kick-Off Meeting conducted by CxA where membership of CxT is established, and responsibilities reviewed. The Commissioning Plan is reviewed during this meeting.
3. CxA schedules subsequent meetings as necessary to plan, coordinate and schedule Commissioning activities. Deficiencies and problem resolution will also be discussed at these meetings.
4. Construction Manager submits copies of submittals for all equipment to be commissioned to CxA for review concurrently with A/E review. CxA reviews equipment submittals and forwards review comments to A/E and OR.
5. Construction Manager submits copies of final A/E approved submittals for all equipment to be commissioned to CxA for record purposes. CxA revises Cx Plan if required.
6. Construction Manager develops initial outline Owner Training Program and submits to CxT for review.
7. Subcontractors install commissioned equipment/systems. CxA makes periodic site visits to review commissioned equipment installations and execute Pre-Functional Checklists. CM/Subcontractors provide the necessary personnel to assist CxA (e.g., provide room access, provide ladders, remove A/C unit covers, open electrical panel covers, etc.) with sample PFC verifications.
8. Any issues noted by CxA are tracked in a Master Issues List (Cx MIL) in the Cx Database. Subcontractors correct issues noted by CxA and update Cx MIL in Cx Database for CxA verification of issue corrections.
9. CM develops Start-Up Plans. CM/Subcontractors coordinate overall schedule of equipment/systems Testing and Start-Up and submit schedule to CxA so that CxA may witness Testing and Start-Up activities as required.
10. Subcontractors complete testing (e.g., duct and piping pressure testing, piping flushing, etc.) as required by Division 20, 21, 22, 23, 26, and 28 specifications. Subcontractors compile completed testing documentation in the Start-Up Plan. CM/Subcontractors submit Start-Up Plan to CxA for verification of completion of testing activities prior to Functional Performance Tests.
11. CxA conducts a Commissioning Functional Testing Schedule Meeting with the CxT to establish a coordinated approach to the integration of the Functional Performance Testing activities within the Master Construction Schedule. CxA conducts Cx FMS Trend Data Planning meeting as a part of this meeting.
12. Subcontractors and Equipment Vendors/Suppliers perform Start-Up and Initial Checkout per the Start-Up Plan documentation and checklists. CM/Subcontractors compile completed Start-Up and Initial Checkout documentation in the Start-Up Plan. CM/Subcontractors submit Start-Up Plan to CxA for verification of completion of Start-Up activities prior to Functional Performance Tests.
13. Facility Management System Contractor sets up required FMS System trending and reporting for CxA review to assess readiness for Functional Performance Tests.
14. CM submits Systems Manual documentation to CxA.
15. Functional Performance Tests are executed by CM and Subcontractors, under supervision of and documented by CxA.
16. Items of non-compliance in material, installation or set-up will be corrected at CM expense and system shall be retested.
17. CM executes Owner Training exercises per Owner Training Plan.
18. CxA issues Final Commissioning Report.
19. CxA completes LEED Online documentation for project certification.
20. Opposed Season Functional Performance Tests are scheduled by the CM. Opposed Season Functional Performance Tests are executed by CM and Subcontractors, under

supervision of and documented by CxA. Subcontractors correct any issues noted from Opposed Season Functional Performance Tests.

21. CxT participates in End of Warranty Review Meeting with facility maintenance staff to review systems performance. An updated Warranty Phase Issue Log shall be generated, and the CM shall resolve all issues determined by the CxT to be subject to project Warranty requirements.
22. CxA issues Opposed Season Functional Performance Test Report and Warranty Review Meeting Minutes for insertion in Final Commissioning Report.

3.2 SYSTEMS TO BE COMMISSIONED

A. GENERAL:

1. CxA PFC and FPT for 100% of equipment listed below with the following exceptions:

    a. Parking Garage is excluded from CxA scope.
    b. Equipment/systems the Level 4 Shelled areas are excluded from CxA scope with the exception of the HVAC terminal equipment (heaters, air terminal boxes, split systems, etc.) installed to provide tempering to shelled spaces for extended periods prior to fit-outs.
    c. Terminal Devices (e.g., VAV Boxes, Venturi Valves, Fan Coil Units, Lighting Control Occupancy Sensors, Door Access Controls, Fire Alarm Device verifications, etc.) on Levels 5, 6, and 7 will be commissioned (PFC and FPT) at a 25% sampling rate.

B. FIRE SUPPRESSION:

1. Fire Pump and Jockey Pump.
2. Any Facility Management System (FMS) integration or monitoring of commissioned Fire Suppression systems and alarms.
3. FMS System trending data for 100% of the Fire Suppression systems and alarms monitored or controlled by the FMS.

C. PLUMBING:

1. Domestic Water Booster Pumps
2. Domestic Hot Water System. Domestic Hot Water System FPT will include sample verification of HW Delivery to most remote fixtures on each level.
3. Safety Plumbing Fixtures (Emergency Eyewashes, Showers).
4. Water Softener System.
5. RO/DI System.
6. Vacuum Systems.
7. Compressed Air Systems.
8. Fuel Oil Storage and Distribution System.
9. Any Facility Management System (FMS) integration or monitoring of commissioned Plumbing systems and alarms.
10. FMS System trending data for 100% of the Plumbing systems and alarms monitored or controlled by the FMS.

D. MECHANICAL / HEATING, VENTILATING AND AIR CONDITIONING (HVAC):

1. Heat Recovery Chillers.
2. Condensing Boilers.

3. Heat Exchangers.
4. Steam PRVs.
5. Hydronic Pumps.
6. Fans.
7. Air Handling Units.
8. Fan Coil Units.
9. CRAC Units.
10. VAV Boxes and Venturi Valves:

    a. Testing will include 8-hour FMS trending in normal operation prior to CxA FPT. Trending data must indicate operation with no deficiencies prior to scheduling CxA FPT.
    b. Testing will include 4-hour FMS “forced” trending in each operational mode (peak cooling, peak heating, any special sequences like CO2, DCV or dehumidification, any special alarms, etc.) prior to CxA FPT. Trending data must indicate operation with no deficiencies prior to scheduling CxA FPT.

11. Baseboard Heaters.
12. Hydronic Coils.
13. Unit Heaters.
14. Variable Frequency Drives.
15. Humidifiers.
16. Critical Space Pressure Monitors/Alarm Systems.
17. Fuel Oil Storage and Distribution System.
18. Facility Management Systems (FMS) for all commissioned equipment including integration into UK Campus “Tridium” System. CxA FPT of FMS will include sample verification (40 hrs.) of FMS Contractor control device calibrations and BAS point-to-point verifications.
19. FMS trending data for 100% of the HVAC equipment monitored or controlled by the FMS.

E. ELECTRICAL:

1. The Variable Frequency Drives (VFD), Motor Control Panels/Motor Starters for all commissioned equipment.
2. Lighting Control Systems including Scheduled Event control, Occupancy Sensor control and Daylight Harvesting controls.
3. The Emergency Power System including Generators, Paralleling Gear, Transfer Switches, Load Banks and remote annunciation, etc.
4. Power Monitoring and Control System.
5. Normal Power Distribution Equipment monitored by the Power Monitoring and Control System, or any equipment monitored for the purpose of Energy Monitoring for ASHRAE 90.1.
6. Coordination of Breakers in commissioned Electrical Equipment including reviewing the Protective Device Coordination Study and confirming installed settings in the field.
7. Confirming Arc Flash Labeling per Arc Flash Study for commissioned Electrical Equipment.
8. Comprehensive Black Site Test (BST) encompassing the verification of all commissioned systems and Emergency Lighting (interior and exterior) functional performance while under emergency power (loss of normal power – transfer to emergency power – restoration of normal power).
9. Any Facility Management System (FMS) integration or monitoring of commissioned Electrical equipment/systems.
10. FMS System trending data for 100% of the Electrical equipment monitored or controlled by the FMS.

F. ELECTRONIC SAFETY AND SECURITY:

1. Security Systems including Access Control and Video Surveillance.
2. The Fire Alarm System including interface with other systems such as Emergency Power, Fire Suppression, HVAC Systems, Elevators, Stairwell Pressurization, etc. Fire Alarm System Functional Testing will include testing each prototypical alarm sequence in each Fire Alarm Zone and verification of Fire Alarm devices to ensure correct alarm notification, labeling of device, activation of general alarm, etc. CxA Fire Alarm System FPT will be conducted separately from and prior to any required Fire Marshal, Code Official or Authority Having Jurisdiction (AHJ) testing.

G. OTHER SYSTEMS:

1. Elevators (FPT only). Elevator interface operation with Fire Alarm and Emergency Power System only.
2. Renewable Energy Systems (if any).

3.3 RESPONSIBILITIES OF COMMISSIONING TEAM MEMBERS

A. Architect/Engineer (A/E):

1. Document design intent of systems. Respond to any issues developed during the commissioning process that may require clarification of design intent.
2. Provide final copy of Basis of Design Document (BOD) for inclusion in Systems Manual.
3. Provide PDF files of design documents required for Systems Manual.

B. Commissioning Agent (CxA):

1. Facilitate cooperation of CxT in Commissioning work.
2. Provide periodic progress reports of Commissioning status.
3. Review, track and coordinate resolution of non-compliance and deficiencies identified by CxT. Maintain Master Issues List (MIL), Resolution List, & Testing Records. Maintain records of all issues submitted by CxT.
4. Identify Commissioning activities and durations for inclusion into the project schedule by the Construction Manager. Review schedule periodically with CxT to ensure commissioning activities are properly reflected. Participate in the “Reverse Phase Scheduling Meeting” with the CxT to verify construction schedule has allowed sufficient time for completion of commissioning activities.
5. Attend and chair CxT meetings as required.
6. Develop Construction Phase Commissioning Plan including project specific Pre-Functional Checklists and Functional Performance Test procedures.
7. Conduct initial Commissioning Kick-Off Meeting to review Cx Plan and responsibilities of each member of the CxT.
8. Review shop drawings for equipment to be commissioned concurrent with the A/E. Provide submittal review comments to OR and A/E for inclusion in the submittal comments returned to the Construction Manager.
9. Review final A/E approved shop drawings for equipment to be commissioned and modify Cx Plan if required.
10. Review A/E approved control submittal sequences of operation and update Commissioning Plan Functional Performance Tests (FPTs) if required. Work with Construction Manager, FMS Contractor, and AE until sufficient clarity has been obtained, in writing, to update Commissioning Plan FPTs.
11. Review initial outline Owner Training Program developed by Construction Manager.

12. Make periodic site visits to review commissioned equipment installations and execute Pre-Functional Checklists (PFC) in Cx Database. Provide a summary Site Visit Report following each site visit.
13. Attend construction meetings as necessary. Typically, periodic site visits will be scheduled to allow attendance at regularly scheduled contractor progress meetings.
14. Prior to equipment Start-Up, conduct a Commissioning Functional Testing Schedule Workshop (Web Meeting) with the CxT in order to establish a coordinated approach to the integration of the Cx FPT activities within the Master Construction Schedule.
15. As a part of the Commissioning FPT Schedule Workshop:

    a. Coordinate scheduling and CxA participation in witnessing FMS Start-Up activities (control device calibrations, point-to-point verifications) with FMSC.
    b. Conduct Cx FMS Trend-Logging Plan Meeting with FMSC to coordinate FMS trending requirements for Cx.

16. Make periodic site visits to witness Subcontractor Testing and Start-Up activities (major equipment/systems).
17. Make periodic site visits to witness FMSC Start-Up activities (40 hrs. total).
18. Review final executed Start-Up Plan systems testing and equipment Start-Up documentation completed by Subcontractors and Vendors prior to Functional Performance Testing to verify systems readiness for CxA testing.
19. Review O&M documentation submitted by Construction Manager for compliance with the project specifications.
20. Review the final Test and Balance report prior to Functional Performance Testing to verify systems readiness for CxA testing. Report any comments to CxT.
21. Provide benchtop testing of BAS system programming (review programming and conduct “dry run” test for each distinct sequence with the FMSC.
22. Review FMS Trend Data prior to Functional Performance Testing to verify systems readiness for testing.
23. Witness FPTs. Document test results and recommend system for acceptance.
24. As a part of the FPTs, verify accuracy of Final TAB Report by witnessing TAB Contractor Verification readings.
25. Monitor the completion of the Owner Training exercises by:

    a. Attending a sampling of the Owner Training exercises.
    b. Digitally videotaping O&M staff training sessions.
    c. Reviewing the final executed Owner Training Program documentation submitted by the CM/Subcontractors at the completion of the Owner Training exercises.

26. Provide Final Commissioning Report, summarizing final disposition of building systems after Functional Performance Testing.
27. Complete LEEDv4 Fundamental Cx and Enhanced Cx Online templates required for project certification.
28. Witness Opposed Season Functional Performance Testing and document results.
29. Conduct End of Warranty Review with CxT and Facilities Staff and document findings for commissioned systems.
30. Append Final Commissioning Report as required for Opposed Season Functional Performance Testing and End of Warranty Review Meeting Minutes.

C. Construction Manager:

1. The Construction Manager leads the commissioning process for the construction team and facilitates cooperation of Subcontractors in executing and completing the commissioning work. In addition to the specific Construction Manager commissioning roles and responsibilities specified herein, the Construction Manager is ultimately

responsible for ensuring that the Subcontractor commissioning roles and responsibilities of this specification are executed and completed as specified.

2. Ensures resolution of non-compliance and deficiencies of construction related items identified by CxA. Ensures Cx Database Master Issues List (MIL) is updated by Subcontractors to reflect deficiency item corrections for CxA verification. Updates to Cx Database regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
3. Notifies CxA of completion of Commissioning Activities (e.g., Cx MIL deficiency issue corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via Cx Database. Updates to Cx Database regarding status of Commissioning activities shall be made within two working days of activity completion.
4. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
5. Attend Commissioning Kick-Off Meeting, and other CxT Meetings.
6. Attend Commissioning Scheduling Meetings to coordinate the integration of the Cx activities in the Master Construction Schedule. Update the Master Construction Schedule to include all Cx activities.
7. Periodically update Commissioning activities in the construction schedule and provide construction schedule updates to CxT. Attend and participate in the “Reverse Phase Scheduling Meeting” with the CxT to verify construction schedule has allowed sufficient time for completion of commissioning activities.
8. Submit copies of submittal data for commissioned equipment, with manufacturer Start-Up criteria, Subcontractor/Vendor Start-Up checklists, and Operating and Maintenance criteria to CxA for review simultaneous with A/E review.
9. Submit copies of final A/E approved submittal data for all commissioned equipment to CxA for record purposes.
10. Provide necessary personnel to assist CxA with execution of the PFCs during periodic CxA site visits (e.g., provide site and space access, provide ladders, etc.).
11. Develop, with cooperation of Subcontractors/Vendors, detailed Owner Training Program. Submit initial outline Owner Training Program to CxT for review within 60 days of completion of submittal process (i.e., all equipment/systems approved by A/E). Revise Owner Training Program as required based on CxA review comments.
12. Oversee development of equipment Start-Up Plan by and execution of equipment Start-Up checks by Subcontractor/Vendors.

    a. Ensure equipment Start-Up Plan is developed and contains forms for all required Testing and Start-Up activities.
    b. With Subcontractors, develop overall schedule of Testing and Start-Up activities. Submit final Testing and Start-Up schedule to CxA 30 days prior to start of any such activities to allow CxA to schedule site visit trips to witness activities as required.
    c. Ensure final executed Start-Up Plan is submitted to CxA prior to start of Functional Performance Testing. Ensure final executed Start-Up plan is organized and contains all documentation required by this specification before submitting to CxA.

13. Attend the Cx FPT Schedule Workshop (Web Meeting) conducted by CxA with the CxT in order to establish a coordinated approach to the integration of the Cx FPT activities within the Master Construction Schedule. Update the Master Construction Schedule to include all Cx FPT activities. Attend Trend-Logging Plan Meeting with CxA and FMSC.
14. Assures CxA that equipment and systems are ready for FPTs. Verifies that the following activities are completed, and documentation submitted to CxA as a prerequisite for FPTs:

    a. All deficiency items noted by CxA prior to Functional Performance Testing are corrected by Contractors and MIL is updated accordingly.
    b. Executed Start-Up Plan electronic PDF files submitted to CxA including:

1) All equipment/systems testing documents completed by Subcontractors.
2) All equipment/systems Start-Up documents completed by Subcontractors/Vendors.
3) All FMS Start-Up documentation completed by FMSC. FMS point-to-point and control device calibration documentation included.
4) Maintenance logs of all interim maintenance tasks performed by Subcontractors/Vendors on all equipment from initial Start-Up through final Owner acceptance, so warranties are not void.

c. Verify Subcontractors and FMSC have confirmed equipment control integration (LonTalk, BACnet, MODBUS, etc.) into FMS.
d. Attend and verify completion of CxA/FMSC benchtop testing of BAS system programming ("dry run" test for each distinct control sequence).
e. Final Test and Balance Report is submitted to CxA for review.
f. O&M documentation submitted to CxT for review.
g. FMS Trend Data is submitted to CxA for review.
h. Systems Manual documentation submitted to CxA.
i. Final schedule for Owner Training exercises submitted to CxA.

15. Schedule, coordinate and assist CxT in FPTs. Attend and participate in Cx FPTs as required to ensure Subcontractor and Equipment Vendor participation and completion of scheduled FPT activities. At a minimum, the Construction Manager should be present at start and completion of daily FPT activities to ensure Subcontractor/Equipment Vendor participation and completion of Functional Testing work.
16. Verify Subcontractors correct deficiencies identified during FPTs. Schedule, coordinate and attend any retesting required to verify FPT deficiency corrections.
17. Coordinate training sessions and execute training per Owner Training Program through the Subcontractors/Vendors.
18. Submit maintenance logs of all interim maintenance tasks performed by Subcontractors/Vendors on all equipment from initial Start-Up through final Owner acceptance so warranties are not void.
19. Schedule, coordinate and assist CxT in Opposed Season FPTs. Verify Subcontractors correct deficiencies identified during Opposed Season FPTs. Schedule, coordinate and attend any retesting required to verify Opposed Season FPT deficiency corrections.
20. Schedule, coordinate, and lead the End of Warranty Review Meeting to review system/equipment performance. Correct any deficiency issues noted during Warranty Period per the Project Warranty Process.

D. Subcontractors and Equipment Vendors:

1. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
2. Attend Commissioning Kick-Off Meeting and other CxT Meetings.
3. Assist CxT with developing a comprehensive Commissioning schedule. Attend Commissioning Scheduling Meetings to coordinate the integration of the Cx activities in the Master Construction Schedule. With Construction Manager, update the Master Construction Schedule to include all Cx activities. Attend and participate in the "Reverse Phase Scheduling Meeting" with the CxT to verify construction schedule has allowed sufficient time for completion of commissioning activities.
4. Notify CxA of completion of Commissioning Activities (e.g., deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via Cx Database. Updates to Cx Database regarding status of Commissioning activities shall be made within two working days of activity completion.
5. Provide necessary personnel to assist CxA with execution of the PFCs during periodic CxA site visits (e.g., provide equipment model/serial number list, provide ladders, remove A/C unit covers, open electrical panel covers, etc.).

6. Correct deficiencies of construction related items identified by CxA. Update Cx Database to reflect deficiency item corrections for CxA verification. Updates to Cx Database regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
7. Develop Start-Up Plan with Construction Manager.
8. Prepare Owner Training Program with Construction Manager.
9. Execute all required equipment and systems testing as required by project specifications (e.g., duct pressure testing, piping pressure testing, piping flushing, electrical acceptance testing, etc.). Provide schedule of testing activities to CxA 30 days prior to start of any testing so that CxA may witness a sampling of the testing. Submit completed testing documentation in final executed Start-Up Plan electronic PDF files to CxA for review prior to start of Functional Performance Testing.
10. Attend the Cx FPT Schedule Workshop (Web Meeting) conducted by CxA with the CxT in order to establish a coordinated approach to the integration of the Cx FPT activities within the Master Construction Schedule. With Construction Manager, update the Master Construction Schedule to include all Cx FPT activities. Attend Cx FMS Trend-Logging Plan Meeting with CxA, Construction Manager, and FMSC.
11. Execute equipment Start-Up per Start-Up Plan. Provide schedule of equipment Start-Up activities to CxA 30 days prior to beginning any equipment Start-Up so that CxA may witness a sampling of the equipment Start-Up activities. Submit completed Start-Up documentation in final executed Start-Up Plan electronic PDF files to CxA prior to start of Functional Performance Testing.
12. Execute all periodic maintenance required on started equipment from initial Start-Up of equipment to final acceptance by Owner to prevent equipment warranties from being voided. Document execution of periodic maintenance by signing and dating maintenance logs for each item of equipment. Submit maintenance log documentation in final executed Start-Up Plan electronic PDF files to CxA prior to start of Functional Performance Testing.
13. Ensure installation work is complete, is in compliance with Contract Documents and is ready for Functional Performance Testing.

    a. Verify all deficiency items noted by CxA prior to Functional Performance Testing are corrected and MIL is updated in Cx Database. Deficiency item status updates should be made within two days of completion of corrective work.
    b. Verify Start-Up Plan electronic PDF files are forwarded to Construction Manager/CxA.
    c. Confirm equipment control integration (LonTalk, BACnet, MODBUS, etc.) into FMS.
    d. With Construction Manager, compile O&M documentation and submit to CxT for review.
    e. With Construction Manager, compile Systems Manual documentation and submit to CxA.
    f. Attend and participate in CxA/FMSC benchtop testing of BAS system programming (“dry run” test for each distinct control sequence) as required (for equipment/systems integrated with FMS).
    g. Notify CxT that equipment and systems are ready for Functional Performance Testing.

14. Provide certified and calibrated instrumentation required to take measurements of system and equipment performance during FPTs.

    a. Electrical Subcontractor shall provide full capacity Load Banks for Emergency Power System Testing. Full capacity Load Banks may be required during separate testing periods (three or more) depending on construction completion and

equipment readiness for testing. Provide Load Banks for one week testing period for each system test to allow for potential weather events.

15. Execute FPTs developed by CxA as described in contract documents and Commissioning Plan. FPT test results will be documented by CxA.

    a. Electrical Subcontractor and Lighting Control System Vendor/Authorized Manufacturer Representative shall demonstrate complete operation of Lighting Control Systems during CxA FPT separate from and in addition to any other required Owner Demonstrations or Owner Training (i.e., Lighting Control System Vendor/Authorized Manufacturer Representative shall include separate site visit trip(s) for Commissioning Lighting Control System Functional Performance Testing).

16. Correct deficiencies identified during FPT. Conduct any retesting required to verify FPT deficiency corrections.
17. Execute training per Owner Training Program.
18. Execute Opposed Season FPTs. Correct deficiencies identified during Opposed Season FPTs. Conduct any retesting required to verify Opposed Season FPT deficiency corrections.
19. Subcontractors shall ensure Equipment Provider Technician and/or Authorized Manufacturer's Representative on-site participation in FPT and Opposed Season FPT as required; along with FMSC, to demonstrate commissioned equipment/system operation.

    a. Equipment Provider Technician and/or Authorized Manufacturer's Representative shall be skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during FPTs and Opposed Season FPTs.
    b. Equipment Provider Technician and/or Authorized Manufacturer's Representative shall provide instrumentation, computer, software, and communication resources necessary to demonstrate total operation of commissioned equipment during FPTs and Opposed Season FPTs.

20. Attend and participate in the End of Warranty Review Meeting to review system/equipment performance. Correct any deficiency issues noted during warranty period per the Project Warranty Process.

E. Facility Management System Contractor (FMSC):

1. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
2. Attend Commissioning Kick-Off Meeting and other CxT Meetings.
3. Assist CxT with developing a comprehensive Commissioning schedule. Attend Commissioning Scheduling Meeting to coordinate the integration of the Cx activities in the Master Construction Schedule. Update the Master Construction Schedule to include all Cx activities. Attend and participate in the "Reverse Phase Scheduling Meeting" with the CxT to verify construction schedule has allowed sufficient time for completion of commissioning activities.
4. Notify CxA of completion of Commissioning Activities (e.g., deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via Cx Database. Updates to Cx Database regarding status of Commissioning activities shall be made within two working days of activity completion.
5. Provide necessary personnel to assist CxA with sample verification of the Pre-Functional Checklists for Facility Management System as required during periodic CxA site visits

(e.g., provide equipment model/serial number list, provide ladders, remove/open control panel covers, etc.)

6. Correct deficiencies of construction related items identified by CxA. Update Cx Database MIL to reflect deficiency item corrections for CxA verification. Updates to Cx Database MIL regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
7. Prepare Owner Training Program with Construction Manager.
8. Following A/E approval of FMS submittal (and prior to FMS Start-Up), provide the following documentation to CxA:

    a. Master List of FMS Points (see Part 2 FMS Trend Data requirements for Master List Point documentation required).
    b. Master List of DDC Control Devices (e.g., valves, dampers, actuators, sensors, flow measuring devices, etc.).
    c. FMS Point-to-Point Verification Checklists to be executed during FMS Start-Up.
    d. FMS Control Device Checklists to be executed during FMS Start-Up.

9. Completely install and thoroughly inspect Start-Up, test, adjust, calibrate and document systems and equipment under FMS Contract.
10. Provide laptop computer, software and training to accommodate TAB Contractor in system balancing.
11. Maintain database of FMS/DDC parameters submitted by TAB Contractor subsequent to field adjustments and measurements.
12. Submit schedule of FMS Start-Up activities to CxA 30 days prior to beginning any Start-Up work to allow CxA to witness FMS Start-Up activities. Coordinate and scheduled site visits for CxA to witness FMS Start-Up activities (40 hrs.). Provide on-site technician skilled in software programming and hardware operation to assist CxA during CxA verifications of DDC Control Device calibrations and point-to-point checks required during Start-Up.
13. Maintain comprehensive records of all FMS Start-Up records including but not limited to system calibration checkout records and point-to-point checklists. Submit completed Start-Up documentation in final executed Start-Up Plan electronic PDF files to CxA prior to start of FPT.
14. Attend the Cx FPT Schedule Workshop (Web Meeting) conducted by CxA with the CxT in order to establish a coordinated approach to the integration of the Cx FPT activities within the Master Construction Schedule. With Construction Manager, update the Master Construction Schedule to include all Cx FPT activities.
15. As a part of the Cx FPT Scheduling Workshop (Web Meeting), attend Cx FMS Trend-Logging Plan Meeting with Construction Manager prior to FPT to coordinate FMS trending requirements.
16. Conduct benchtop testing of BAS system programming (review programming and conduct “dry run” test for each distinct sequence) with CxA and other members of the CxT.
17. Ensure installation work is complete, is in compliance with Contract Documents and is ready for Functional Performance Testing.

    a. Verify all deficiency items noted by CxA prior to Functional Performance Testing are corrected and MIL is updated in Cx Database. Deficiency item status updates should be made within two days of completion of corrective work.
    b. Verify Start-Up Plan electronic PDF files are forwarded to /CxA.
    c. Confirm equipment control integration (LonTalk, BACnet, MODBUS, etc.) into FMS.
    d. With Construction Manager, compile O&M documentation and submit to CxT for review.

e. With Construction Manager, compile Systems Manual documentation and submit to CxA.
f. Complete benchtop testing of BAS system programming (review programming and conduct “dry run” test for each distinct sequence) with CxA and other members of the CxT.
g. Submit one week of operating FMS trend data (either automatically or manually) to CxA for review to assess the readiness of the specific system to begin on-site FPT. Submit FMS trend data to CxA for review a minimum of seven (7) days prior to scheduled FPT.
h. Submit Systems Manual documentation to CxA.
i. Notify CxT that equipment and systems are ready for Functional Performance Testing.

18. Provide instrumentation, computer, software, and communication resources necessary to demonstrate total operation of building systems and control system equipment during FPTs.
19. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during FPTs. Conduct any retesting required to verify FPT deficiency corrections.
20. Execute training per Owner Training Program.
21. Provide instrumentation, computer, software, and communication resources necessary to demonstrate total operation of building systems and control system equipment during Opposed Season FPTs.
22. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during Opposed Season FPTs. Conduct any retesting required to verify Opposed Season FPT deficiency corrections.
23. Attend and participate in the End of Warranty Review Meeting to review system/equipment performance. Correct any deficiency issues noted during warranty period per the Project Warranty Process.

F. Test, Adjust and Balance (TAB) Contractor:

1. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
2. Attend Commissioning Kick-Off Meeting and other CxT Meetings.
3. Assist CxT with developing a comprehensive Commissioning schedule. Attend Commissioning Scheduling Meetings to coordinate the integration of the Cx activities in the Master Construction Schedule. Update the Master Construction Schedule to include all Cx activities. Attend and participate in the “Reverse Phase Scheduling Meeting” with the CxT to verify construction schedule has allowed sufficient time for completion of commissioning activities.
4. Correct deficiencies of construction related items identified by CxA. Update Cx Database MIL to reflect deficiency item corrections for CxA verification. Updates to Cx Database MIL regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
5. Notify CxA of completion of Commissioning Activities (e.g., deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via Cx Database. Updates to Cx Database regarding status of Commissioning activities shall be made within two working days of activity completion.
6. Prepare Owner Training Program with Construction Manager.
7. Submit TAB Plan and forms describing methodology for execution of test and balance procedures specific to this project to CxT for review.
8. Cooperate with FMSC with execution of required work.

9. Coordinate schedule for all TAB activities with CxA. Provide CxA with final schedule for all TAB activities 30 days prior to starting TAB work to allow CxA to schedule site visits to witness TAB work and readings.
10. Attend the Cx FPT Schedule Workshop (Web Meeting) conducted by CxA with the CxT in order to establish a coordinated approach to the integration of the Cx FPT activities within the Master Construction Schedule. With Construction Manager, update the Master Construction Schedule to include all TAB and Cx FPT activities.
11. Submit copy of Final TAB report to CxA for review prior to start of Functional Performance Testing.
12. Submit Systems Manual documentation to CxA.
13. Provide on-site technician and equipment, as necessary, skilled in TAB procedures to provide verification of equipment and system performance and to correct any TAB deficiencies identified during FPTs. Conduct any retesting required to verify FPT deficiency corrections.
14. Provide on-site technician and equipment, as necessary, skilled in TAB procedures to provide verification of Final TAB Report air and water readings to CxA.

    a. Final TAB Report Verification Readings are separate from and in addition to TAB Contractor equipment performance verifications during CxA Functional Performance Testing.
    b. Allow 80 hours for Final TAB Report Verification Readings.

15. Execute training per Owner Training Program.
16. Provide on-site technician and equipment, as necessary, skilled in TAB procedures to provide verification of equipment and system performance and to correct any TAB deficiencies identified during Opposed Season Functional Performance Testing. Conduct any retesting required to verify Opposed Season FPT deficiency corrections.
17. Attend and participate in the End of Warranty Review Meeting to review system/equipment performance and operations. Correct any deficiency issues noted during warranty period per the Project Warranty Process.

3.4 COMMISSIONING TEAM (CxT) MEETINGS

A. CxT meetings will be held periodically as determined by CxA with frequency increasing as construction advances and systems become operational. Attendance is mandatory. CxA will record minutes and attendance. CxA will chair CxT Meetings.

B. Discussions held in CxT meetings shall include, but not be limited to PFC completion, system/equipment Start-Up, progress, scheduling, testing, documentation, deficiencies and problem resolution.

3.5 REPORTING

A. CxA will provide regular status reports to Construction Manager and Owner, with increasing frequency as construction and Commissioning progresses.

B. CxA will regularly communicate with members of CxT, keeping them apprised of Commissioning progress.

C. CxA shall submit non-compliance and deficiency reports to Owner and Construction Manager.

D. CxA shall provide a Final Commissioning Report to Owner.

3.6 SUBMITTAL REVIEWS.

A. CxA shall review submittals for commissioned equipment concurrently with A/E. CxA shall review submittals:

1. For conformance as it relates to commissioning. Review is primarily intended to aid in development of Functional Testing procedures and only secondarily to verify compliance with equipment specifications.
2. To ensure maintenance and operation requirements are addressed.
3. To verify compliance with the Basis of Design and Owner's Project Requirement information provided by the A/E.

B. CxA submittal review comments will be submitted to the A/E and OR for review. A/E shall review CxA submittal review comments to determine if the comment should be included in the formal A/E submittal review comments returned to the Construction Manager.

C. Construction Manager shall submit one copy of the final A/E approved submittal data to the CxA for record purposes.

D. CxA will update Cx Plan PFCs and FPTs if required based on final A/E approved submittals.

3.7 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. CxA will complete the Pre-Functional Checklists in the Cx Database.

B. Any deficiency issues noted will be included and tracked in the Master Issues List in the Cx Database.

3.8 MASTER ISSUES LIST (MIL)

A. Commissioning Issues will be tracked from initial notice by CxA through correction via the Cx Database as follows:

1. Open Issue:

a. Issues noted by the CxA during periodic site visits will be included in the Cx Database Master Issues List (MIL).

2. Recheck Issue:

a. The Subcontractors shall correct the deficiency items and notify the CxA when the items are corrected and ready for CxA verification by updating the deficiency item status from "Open" to "Recheck" in the Cx Database. CxA does not recheck issues until they have been noted ready for "Recheck" in the Cx MIL by the Subcontractor that corrected the issue.

3. Closed Issue:

a. The CxA will verify the correction and update the item status from "Recheck" to "Closed" in the Cx Database.

B. Costs for CxA to reverify any Issue marked by the Subcontractor for CxA recheck and found to be incomplete will be considered Additional Services (see paragraphs below for CxA costs).

3.9 START-UP AND INITIAL CHECKOUT

A. Construction Manager shall schedule all required Systems Testing and Equipment Start-Up with CxT. Subcontractors and Equipment Vendors shall execute Systems Testing and Equipment/Systems Start-Up per the Start-Up Plan.

B. Construction Manager shall submit final schedule of Testing and Start-Up activities to CxA 30 days prior to any testing or Start-Up activity to allow CxA to witness as required.

C. Subcontractors shall execute equipment/systems Testing and Start-Up per Start-Up Plan, document results and compile/organize all Start-Up Plan documentation into electronic PDF files (searchable from Table of Contents to each documentation item).

D. Construction Manager shall forward copy of completed Start-Up Plan PDF files to CxA for review to verify completion of Start-Up activities. Executed Start-Up Plan PDF files must be submitted to CxA prior to start of Functional Testing.

E. Construction Manager shall clearly list outstanding items or Testing/Start-Up activities that are not completed successfully. Updates to Cx Database regarding corrections of any Testing and Start-Up deficiency issues shall be made within two working days of completion of retesting work.

F. Construction Manager shall submit an updated Start-Up report and Statement of Correction on any incomplete or non-compliance report.

G. Any Testing or Start-Up activity marked as completed which is later found to be incomplete and causes re-verification work by CxA, delays during Functional Performance Testing, or retesting will be considered Additional Services (see paragraphs below for CxA costs).

3.10 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope:

1. The objective of Functional Performance Testing is to demonstrate each system is operating according to documented design intent and Contract Documents. Functional Performance Testing facilitates bringing systems from a state of substantial completion to full dynamic operation. Additionally, during Functional Performance Testing, areas of deficient performance are identified and corrected, improving operation and functioning of systems.
2. Each system shall be operated through all modes of operation (occupied, unoccupied, warm-up, cool-down, etc.) where there is a specified system response. Verifying each sequence in the sequences of operation is required.
3. Functional Performance Testing is separate from, and in addition to, any other Start-Up, Testing, Demonstration or Commissioning required in other Sections of the Project Manual.
4. The CxA will document the Functional Performance Testing utilizing the Cx Database.

B. Initial Facility Management Systems (FMS) Checkout:

1. The FMS must be verified for correct operation by the FMSC prior to the CxA witnessing and documenting the FPTs. The Cx FPTs are intended to document completion of the FMS and proper operation of the Commissioned Systems. The Cx FPTs are not intended to serve as a "Quality Control" measure or "Punch List" for the Construction Manager, Facility Management System Contractor or other Subcontractor. The CxA FPTs are not intended to serve as "Beta" testing for the FMS.
2. Prior to CxA FPT, FMSC will complete benchtop testing of BAS system programming (review programming and conduct "dry run" test for each distinct sequence) with CxA and other members of the CxT.
3. The intent of this process is for the FMSC to physically check and verify proper equipment and integrated systems operation for all operational sequences prior to the CxA witnessing and documenting the actual FPT.

C. Coordination and Scheduling:

1. Prior to equipment Start-Up, CxA will conduct a FPT Scheduling Meeting with the CxT in order to integrate the FPT activities into the Master Construction Schedule. The Construction Manager will update the Master Construction Schedule to include all Cx activities.
2. Construction Manager will provide sufficient notice to CxA regarding completion schedule for equipment and systems. Construction Manager will schedule FPTs with CxT. CxA shall witness and document functional testing of equipment and systems. Contractors shall execute tests under direction of CxA.
3. Construction Manager must allow sufficient time in the Construction Schedule to complete the FPT prior to Owner move-in/occupancy. This includes completing the commissioned systems installations, Testing, Start-Up, and all prerequisites required for Functional Performance Testing. CxT will participate in Attend and participate in a "Reverse Phase Scheduling Meeting" to verify construction schedule has allowed sufficient time for completion of commissioning activities. Time and expenses for CxA to complete Functional Performance Testing during Owner move-in or after Owner occupancy will be considered Additional Services (see paragraphs below for CxA costs).
4. FPTs are Integrated Systems Tests. For example, the Fire Alarm System must be complete and ready for operation in order to test the AHU Fire Alarm shutdown sequence. All equipment and systems associated with a FPT must be complete and ready for testing.
5. In general, the Functional Performance Testing will be organized/scheduled based on the following hierarchy:

    a. Project completion. Some areas of the building may be complete before other areas. Priority will be given to these area systems assuming they can be grouped together for Integrated Systems Testing.
    b. Integrated Systems. The testing will be organized into groups of Integrated Systems from larger systems down to smaller systems (e.g., Chilled Water System, Air Handling System, Terminal Units, etc.).
    c. Systems with limited integration and "stand alone" systems (e.g., Unit Heater or Fan only being monitored by the FMS).

6. FPTs will be grouped together to allow testing to be conducted over weekly testing periods to maximize testing efficiencies. Single systems testing spread out over multiple testing weeks will not be allowed. In general, the testing will begin on Monday and end on Friday afternoon. The actual testing hours will be coordinated with the Construction Manager based on the amount of testing work to be completed during that week. Construction Manager and Subcontractors should be prepared to work from 8:00AM to 5:00PM each day to complete the testing for that weekly period.

7. Some systems may require testing after normal working hours (e.g., Lighting Controls, Fire Alarm System integration, etc.) to avoid conflicts with ongoing work or adjacent building operations. This testing will be scheduled for evenings (Monday – Thursday) or early mornings (Tuesday – Friday). Weekend testing will only be allowed if agreed upon by CxT in advance.

D. Prerequisites for Functional Performance Testing:

1. All MIL Issues noted prior to Functional Testing must be corrected and updated in the Cx Database.
2. Construction Manager must submit the fully executed Start-Up Plan electronic PDF files including all equipment and systems testing documentation (e.g., duct and piping pressure testing, cleaning/flushing documentation, etc.), and all executed start up and initial check-out documentation.
3. TAB Contractor shall complete all test and balance work and submit Final Test and Balance Report for review by A/E and CxA. A/E shall review Final Test and Balance Report for acceptance. CxA review of Final TAB Report is cursory (not for acceptance) and is primarily intended to ensure that the equipment and systems are ready to be functionally tested.
4. FMSC must submit all FMS Start-Up and initial checkout documentation (including point-to-point verifications, etc.) in the Start-Up Plan.
5. Commissioned equipment control integration (e.g., LonTalk, BACnet, MODBUS, etc.) to the Control System must be complete and verified by the Equipment Provider and FMSC.
6. FMSC must complete benchtop testing of BAS system programming (review programming and conduct “dry run” test for each distinct sequence) with CxA and other members of the CxT.
7. FMSC must complete FMS system trending data set-up and reporting and submit one week of operating data (either automatically or manually) for CxA review to assess the readiness of the specific system to begin on-site Functional Testing. Operating data must be submitted at least seven (7) days prior to anticipated start of FPT.
8. FMS network and front end must be complete and operational. FMS graphics must be complete.
9. O&M documentation must be submitted to CxA for review.
10. Final schedule of Owner Training exercises must be submitted to CxA prior to scheduling Functional Performance Tests.
11. Systems Manual documentation must be submitted to CxA.

E. Final Test and Balance (TAB) Report Verification:

1. TAB Contractor will allow for 80 hours of Final TAB Report verification readings (both air and water readings). Final TAB Report Verification readings to be focused on critical areas (starting with those equipped with pressure monitors).
2. TAB Contractor will re-read devices with the same equipment used in the TAB process in the presence of the CxA. The devices will be selected at random by the CxA and the CxA will record the TAB Verification readings. All Verification readings must be within ±10% of final TAB report readings.
3. Readings outside of the ±10% tolerance in more than 10% of the TAB Verification readings will indicate failure of the TAB Verification testing and require re-testing. TAB Subcontractor will correct all deficient readings and schedule TAB Verification re-testing with CxA. The CxA will randomly select a different sample of the TAB final report readings for the Verification re-testing.
4. Readings outside of the ±10% tolerance in more than 10% of the TAB Verification re-testing readings will indicate failure of the Verification re-test and will require a second re-testing. TAB Subcontractor will correct all deficient readings and schedule second TAB Verification re-testing with CxA. The TAB Verification re-testing procedures will be

repeated a second time again utilizing a different sample of the final TAB report readings selected at random by the CxA.

5. Readings outside of the ±10% tolerance in more than 10% of the second TAB Verification re-testing readings will require TAB Verification retesting for all the TAB final report readings.
6. All TAB verification retesting will be completed at no additional cost to the Owner. See paragraphs below for CxA costs for retesting.

3.11 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation:

1. CxA will witness and document results of FPT utilizing Cx Database. FPTs are made available to the CxT in the Cx Database for review and approval prior to testing. CxA will include the executed FPTs in the Final Commissioning Report.

B. Non-Conformance:

1. CxA will record results of FPT. Deficiency or Non-Conformance Issues will be noted and reported to Construction Manager and Owner in the Cx Master Issues List (Cx MIL).
2. Corrections of minor deficiencies identified may be made during tests at discretion of CxA. In such cases, deficiency and resolution will be documented in the FPT.
3. Every effort will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. CxA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so by the Owner.
4. Deficiency and Non-Conformance Issues are handled in the following manner:

    a. When there is no dispute on Deficiency Issue and Construction Manager accepts responsibility for remedial action:

        1) CxA documents Deficiency Issue and Subcontractors response and intentions in the Cx MIL and they go on to another test or sequence.
        2) All issues are made available to CxT via the Cx MIL and written Cx Site Visit Reports.
        3) Subcontractor corrects deficiency and updates Issue status to “Recheck” in the Cx MIL.
        4) Construction Manager reschedules test with Subcontractor.
        5) CxA witnesses retesting and documents results. Corrected issues will be updated in the Cx MIL to “Closed”.
        6) See paragraphs below for CxA costs for retesting and reverification work.

    b. When there is a dispute about a Deficiency Issue, regarding whether it is a deficiency or who is responsible:

        1) CxA documents Deficiency Issue and Subcontractors response and intentions in the Cx MIL and they go on to another test or sequence.
        2) All issues are made available to CxT via the Cx MIL and written Cx Site Visit Reports.
        3) Construction Manager facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final acceptance authority is with the Owner.
        4) Construction Manager documents resolution process.

5) Once interpretation and resolution have been decided, appropriate Subcontractor corrects deficiency and updates Issue status to “Recheck” in the Cx MIL.
6) Construction Manager reschedules test and test is repeated until satisfactory performance is achieved.
7) CxA witnesses retesting and documents results. Corrected issues will be updated in the Cx MIL to “Closed”.
8) See paragraphs below for CxA costs for retesting and reverification work.

C. Costs for CxA MIL Verifications and Retesting:

1. Cost for Subcontractor to correct and retest any PFC or FPT deficiency item, if they are responsible for deficiency, will be theirs. If Subcontractor is not responsible, cost recovery for retesting will be negotiated with CM.
2. CxA has included a seventy (70) hour allowance for delays, reverifications and retesting work to be used over the duration of the Cx process. CxA will provide status of retesting allowance to CxT in periodic site visit reports. CxA labor and expenses for any of the following work beyond the 70 hour allowance will be considered Additional Services to be negotiated with the Owner. CxA Additional Service costs must be approved by the Owner for CxA to schedule retesting site visits.

a. Excessive Deficiency Issue Verifications (for excessive/repeated issues).
b. Any reverification of a Deficiency Issue when the Issue is marked as corrected by the CM/Subcontractor and found to remain deficient by CxA on verification.
c. Delays during Functional Performance Testing caused by excessive or repeated testing failures.
d. Any Functional Performance Testing or Opposed Season Functional Performance Testing MIL Issue Verifications or Retesting (for any reason).

D. Costs for Functional Performance Test Additional Services:

1. Cost for CM/Subcontractor to complete Functional Performance Testing Additional Services will be theirs.
2. Additional Services for CxA to complete any Functional Performance Testing during Owner move-in or after Owner occupancy (regardless of whether the testing was attempted prior to that point or not) will be considered Additional Services to be negotiated with the Owner. CxA Additional Service costs must be approved by the Owner for CxA to schedule testing site visits during Owner move-in or after Owner occupancy.

E. Approval:

1. CxA notes each satisfactorily demonstrated function on test form. CxA, A/E and Owner provide formal approval of FPT. CxA recommends acceptance of each test to Owner. The Owner gives final approval, providing a signature to Construction Manager.

3.12 TRAINING OF OWNER PERSONNEL

A. CM/Subcontractors/Vendors will provide complete training in start-up, operation and maintenance of all equipment under contract.

B. Construction Manager and Subcontractors will be responsible for

1. Developing Owner Training Program.
2. Scheduling of Owner Training with Owner and Contractors. Owner Training Schedule will be provided to CxA to allow CxA to schedule site visits to attend training sessions.
3. Execution of Owner Training.
4. Documentation of completed Owner Training.

C. CxA will monitor the completion of the Owner Training as follows:

1. CxA will review Owner Training Program submitted by Construction Manager.
2. CxA will attend a sampling of the Owner Training Sessions.
3. CxA will digitally videotape O&M staff training sessions for commissioned equipment/systems.
4. CxA will review the final executed Owner Training Program documentation.

D. General sequencing of the development of the Owner Training Program and completion of the Owner training is as follows:

1. CxA will review the Owner training requirements (including preparation of Owner Training Program) with the Construction Manager and Subcontractors at the Commissioning Kick-Off meeting.
2. Construction Manager will prepare an outline of the Owner Training Program within 30 days of completion of submittal process (i.e., all equipment/systems approved by A/E). Submit Owner Training Program outline to CxT for review.
3. Schedule for Owner Training sessions will be reviewed and updated as required throughout the project construction by CxT at Construction Manager Progress Meetings (attended by CxA during periodic site visits). Construction Manager will submit final Owner Training Schedule to CxT 30 days prior to start of training exercises to allow CxA to witness the Owner training exercises.
4. Subcontractors and Equipment Vendors will execute training exercises per Training Program including any required comprehension testing and continuing Owner Training exercises.
5. Construction Manager will submit a copy of the following Owner Training documentation to CxA on completion of Owner Training exercises (CxA copy is in addition to any copies required by other specifications for Owner use):

    a. Final executed Owner Training Program and Owner Training Manuals including all training documentation (sign-in sheets, handouts, comprehension tests, etc.). Copy shall be in “searchable” PDF format.

3.13 OPPOSED SEASON FUNCTIONAL PERFORMANCE TESTING

A. During Warranty Period, seasonal testing (tests delayed until weather conditions are closer to system’s design) will be completed as part of this contract. Construction Manager will coordinate this activity.

B. One Opposed Season Test will be conducted (during peak conditions opposite initial Functional Performance Testing). Only seasonally impacted sequences and capacities will be retested during the opposed season test (e.g., safeties and fire alarm interlocks will not be retested during the Opposed Season Tests).

C. Tests will be executed, documented and deficiencies corrected by appropriate contractor(s), with facilities staff and CxA witnessing.

D. CxA will incorporate final updates to the Final Cx Report as necessary.

3.14 END OF WARRANTY REVIEW MEETING

A. CxA will participate in an End of Warranty Review with the Owner and O&M staff to review the facility and commissioned systems performance. End of Warranty Review will be completed 10-11 months into the one-year warranty period.

B. The End of Warranty Review shall address the following (for commissioned systems only):

1. Any outstanding construction deficiencies.
2. Any outstanding warranty period deficiencies identified by the CxA during Opposed Season Testing.
3. Any deficiencies that were noted by the Operations Staff during the warranty period.
4. Any problems noted by the Operations Staff related to operating the facility as originally intended.

C. Any issues covered under a warranty or under the original Contract Documents will be assigned to the Construction Manager for correction per the project warranty process. CM/Subcontractor will correct the issue and notify the Owner of correction. Subcontractor shall provide any retesting or photo documentation required by Owner to verify issue corrections.

D. CxT will determine a process for resolution, including the party responsible for resolution (e.g., A/E, Facility Staff, etc.), for all other non-warranty issues.

E. CxA will document resolution process for all issues in meeting minutes and distribute to the CxT.

3.15 SAMPLE COMMISSIONING DOCUMENTATION

A. Sample Pre-Functional Checklist (PFC), Functional Performance Test (FPT) and Cx BMS Trend Data/Report are included on the following pages.

SSRCx FACILITIES COMMISSIONING

Sample HVAC Pre-Functional Checklist

PROJECT:
LOCATION:

SYSTEM/UNIT: HVAC Equipment/ AHU

Tested By:
Date:

Model Verification - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Specified Manufacturer				
2	Installed Manufacturer				
3	Specified Model #				
4	Installed Model #				
5	Serial #				
6	Specified Airflow				
7	Specified Static Pressure				

General - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Inspection and Access doors are operable				
2	Casing Undamaged				
3	Equipment has been cleaned and finish touched up if necessary.				
4	Manufacturer's required maintenance clearance provided for service.		23 05 [illegible]0 1.8 E		
5	Specified unit mounting requirements		Sch[illegible]ule Note 10		
6	Verify unit is mounted per plans and specs		Schedule Note 10		
7	Specified access doors		Schedule Note 4		
8	Verify access doors are provided per plans and specs		Schedule Note 4		
9	Access doors are installed s[illegible] air leaks through door				
10	Access doors open against air pressure				
11	Specified lights are provided per plans and specs		Schedule Note 5		
12	Verify lights are installed in locations per plans and specs		Schedule Note 5		
13	4" housekeeping pad is provided under all floor mounted equipment		23 05 48 3.4 G		
14	Flexible pipe connectors are installed on all equipment supported by vibration isolation		23 05 48 3.4 L		

Accessories - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Specified accessories are provided (1)		Schedule Note 12		
2	Verify accessories are provided (1)		Schedule Note 12		
3	Specified accessories are provided (2)		Schedule Note 11		
4	Verify accessories are provided (2)		Schedule Note 11		
5	UV lights are factory installed downstream of cooling coils		Schedule Note 16		

FACILITIES COMMISSIONING

Sample HVAC Pre-Functional Checklist

PROJECT:
LOCATION:

SYSTEM/UNIT: HVAC Equipment- AHU

Tested By:
Date:

Ductwork - HVAC Equipment - AHU

	Verification	Response	Notes	By	Date/Time
1	Ductwork is connected to unit with flexible connections		Schedule Note 19		
2	Duct installation is complete				
3	Access doors installed and labeled at fire / smoke dampers, fire dampers, and smoke detectors		23 31 13 3.1 E		

Controls - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Return duct smoke detector is installed in return duct		Schedule Note 19		
2	Supply duct smoke detector is installed after supply fan		Schedule Note 19		
3	Specified return air sensors are installed per the controls schematic		M06-02 Detail C3		
4	Verify return air sensors are installed per the controls schematic		M06-02 Detail C3		
5	Specified mixed air sensors are installed per the controls schematic		M06-02 Detail C3		
6	Verify mixed air sensors are installed per the controls schematic		M06-02 Detail C3		
7	Specified discharge air sensors are installed per the controls schematic		M06-02 Detail C3		
8	Verify discharge air sensors are installed per the controls schematic		M06-02 Detail C3		
9	Specified automatic dampers are installed per the controls schematic		M06-02 Detail C3		
10	Verify automatic dampers are installed per the controls schematic				

Labeling - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Permanently fasten labels are on each major item of mechanical equipment. Labels are located in accessible and visible areas.		23 05 53 2.3 A		
2	Duct is labeled with contents and flow direction		23 05 53 2.3 C		

Insulation - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Specified Air Duct Insulation requirements:		23 07 13 4.1 - EXPOSED: 2" Rigid Fiberglass Board; CONCEALED: 2" Flexible Fiberglass with Vapor Barrier		
2	Verify Air Duct Insulation requirements:		23 07 13 4.1		

Startup Mechanical - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Contractor's executed startup procedures haves been submitted for review				

Sample Electrical Pre-Functional Checklist

PROJECT:
LOCATION:
PROJECT #:

SYSTEM/UNIT: Emergency Equipment/GEN 1
AREA: Exterior

Documentation - Emergency Equipment/GEN 1

	Verification	Response	Notes	By	Date/Time
1	Manufacturer - Specified				
2	Manufacturer - Installed				
3	Capacity / Power Factor - Specified				
4	Capacity / Power Factor - Installed				
5	Voltage - Specified				
6	Voltage - Installed				
7	Engine Model				
8	Engine Serial #				
9	Generator Model				
10	Generator Serial #				

Installation - Emergency Equipment/GEN 1

	Verification	Response	Notes	By	Date/Time
1	Generator installation is clean and clear of debris				
2	Generator is secured to concrete housekeeping pad				
3	Generator installed on steel base				
4	Generator mounted on spring isolators				
5	Provided with flex connection between radiator and exhaust plenum				
6	Flexible fuel lines provided for connection to generator				
7	Provided with flex connection exhaust silencer				
8	All conduit connections consist of flex conduit				
9	Generator installed to provide access for periodic maintenance				
10	Provided with electrically powered, thermostatically controlled jacket water heater(s) to maintain a minimum specified water jacket temperature under ambient temperatures				
11	Critical grade exhaust silencer provided and installed per design				
12	Provided with gas proof, stainless steel, flexible exhaust bellows with threaded NPT or flanged connections				
13	Silencer provided w/ condensate drain				
14	Rain cap and bird screen provided for exhaust pipe				
15	A lube oil drain is extended beyond the skid base				

FACILITIES COMMISSIONING

Sample Electrical Pre-Functional Checklist

PROJECT:
LOCATION:
PROJECT #:

SYSTEM/UNIT: Emergency Equipment/GEN 1
AREA: Exterior

Installation - Emergency Equipment/GEN 1

	Verification	Response	Notes	By	Date/Time
16	Provided with engine mounted combustion air intake filter with a "blocked filter" indicator				
17	Emergency stop pushbutton is installed outside of generator enclosure				
18	Remote annunciation is provided and wired to the generator (annunciator panel, BAS)				
19	Equipment grounding conductor is installed from generator to grounding electrode system. Flexible jumper is provided between base and isolated generator				
20	Specified system grounding				
21	Verify system is grounded as specified				

Display - Emergency Equipment/GEN 1

	Verification	Response	Notes	By	Date/Time
1	Specified display requirements				
2	Verify display provided as specified				
3	Display shock mounted to genset				

Starting System - Emergency Equipment/GEN 1

	Verification	Response	Notes	By	Date/Time
1	Correct number of starting motors are provided				
2	Specified starting system and battery accessories				
3	Verify starting and battery accessories are provided				
4	Automatic battery charger is provided				
5	Specified battery charger features and options				
6	Verify battery charger features are provided				

Sample Electrical Pre-Functional Checklist

PROJECT:
LOCATION:
PROJECT #:

SYSTEM/UNIT: Emergency Equipment/GEN 1
AREA: Exterior

Generator Room \ Enclosure - Emergency Equipment/GEN 1

	Verification	Response	Notes	By	Date/Time
1	Room / enclosure is complete (including doors)				
2	Room / enclosure is provided with thermostatically operated space heater				
3	Louver / damper installation is complete				
4	Room / enclosure provided with bird / rodent screens				
5	Room / enclosure provided with emergency lighting				
6	Convenience receptacles provided				
7	Specified sound attenuation provisions				
8	Verify sound attenuation provisions are provided				

SSRCx FACILITIES COMMISSIONING

Sample HVAC Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: AHU

Tested By:
Date:

1.01 Pre-test Set points & Conditions - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	RECORD: OA Flow				
2	RECORD: Damper Pos				
3	RECORD: OA Temp°F				
4	RECORD: RA Humidity %RH				
5	RECORD: CHW Valve Status/Command				
6	RECORD: CHW Coil LAT				
7	RECORD: VFD - 1 Status/Command				
8	RECORD: VFD - 1 Speed %				
9	RECORD: VFD - 2 Status/Command				
10	RECORD: VFD - 2 Speed %				
11	RECORD: SA Temperature Setpoint/Actual	°F			
12	RECORD: SA Flow Setpoint/Actual				
13	RECORD: Interlocked Exhaust Fan(s) Status/Command				
14	RECORD: Coil DP Setpoint/Actual				
15	RECORD: 2/3 Duct Static Pressure				

1.02 Post-test Set points - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	RESET: Upon completion of test reset set points to pre-test set point values				

Sample HVAC Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: HVAC Equipment/AHU

Tested By:
Date:

2.01 Unit - On - HVAC Equipment/AHU

	Verfication	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Unit is commanded on via building BMS				
2	EXPECTED RESPONSE: Fire/Smoke Dampers are fully opened				
3	EXPECTED RESPONSE: Supply fan is energized and runs continuously during unit operation				
4	EXPECTED RESPONSE: Interlocked Exhaust Fan(s) is energized and runs continuously during unit operation				
5	EXPECTED RESPONSE: VFD(s) modulates to maintain constant flow as filters get loaded				
6	EXPECTED RESPONSE: OA damper opens to minimum airflow position				
7	EXPECTED RESPONSE: RA damper opens fully				
8	EXPECTED RESPONSE: OA damper modulates to maintain OA flow setpoint				
9	EXPECTED RESPONSE: Cooling coil valve modulates to maintain LAT setpoint (50°F, adj.)				
10	VERIFY: Supply fan minimum runtime is programmed				

2.02 Cooling Coil Control HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate OA temp > 45°F				
2	EXPECTED RESPONSE: Cooling Coil is enabled				
3	EXPECTED RESPONSE: Cooling coil control valve modulates to maintain LAT setpoint of 50°F (adj.)				

FACILITIES COMMISSIONING

Sample HVAC Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: HVAC Equipment/AHU

Tested By:
Date:

2.03 Supply Air Reset - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate return air temperature > return air high limit				
2	EXPECTED RESPONSE: Supply air temperature setpoint is reset downward				
3	RECORD: RA Temperature High Limit Setpoint	°F			
4	RECORD: Supply Air Temperature Setpoint/Actual	°F			
5	TEST PROCEDURE: Simulate return air temperature < return air low limit				
6	EXPECTED RESPONSE: Supply air temperature setpoint is reset upward				
7	RECORD: RA Temperature Low Limit Setpoint	°F			
8	RECORD: Supply Air Temperature Setpoint/Actual	°F			

2.04 Unit - Off - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Unit is commanded to shut down via building BMS				
2	EXPECTED RESPONSE: OA damper closes				
3	EXPECTED RESPONSE: CHW Coil opens				
4	EXPECTED RESPONSE: Supply fan deenergizes				
5	EXPECTED RESPONSE: Interlocked exhaust fan(s) deenergizes				

3.01 High Space Temperature Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate space temperature greater than the cooling setpoint by a "user defined amount"				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.02 Low Space Temperature Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate space temperature lower than the cooling setpoint by a "user defined amount"				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

Sample HVAC Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: HVAC Equipment/AHU

Tested By:
Date:

3.03 High Return Air Humidity - AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate RA humidity > 70% (adj.)				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.04 Low Return Air Humidity - AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate RA humidity < 35% (adj.)				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.05 Supply Fan Failure - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate supply fan status does not match command				
2	VERIFY: Remaining supply fan(s) ramp up to maintain supply airflow setpoint				
3	EXPECTED RESPONSE: Alarm is sent to BMS				
4	TEST PROCEDURE: Simulate supply fan runtime exceeded				
5	EXPECTED RESPONSE: Alarm is sent to BMS				
6	RECORD: Runtime Alarm Setpoint				

3.06 Pre Filter DP Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate DP across pre filter > pre filter DP setpoint				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.07 Final Filter DP Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate DP across final filter > final filter DP setpoint				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.08 Smoke/Fire Detection Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate smoke detected/emergency shutdown signal				
2	EXPECTED RESPONSE: Unit shuts down according to shutdown sequence				
3	EXPECTED RESPONSE: Alarm is sent to BMS				

Sample Plumbing Systems Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: Domestic Hot Water System

1.00 Sample FPT - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	Sample FPT				

1.02 Pre-test Setpoints & Conditions - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	RECORD: WH-A Status				
2	RECORD: WH-B Status				
3	RECORD: Recirculation Pump A Status				
4	RECORD: Recirculation Pump B Status				
5	RECORD: DHWR Temperature				
6	RECORD: DHWS Leaving WH-A Temperature Setpoint/Actual				
7	RECORD: DHWS Leaving WH-B Temperature Setpoint/Actual				
8	RECORD: WH-A Circulation Pump Status				
9	RECORD: WH-B Circulation Pump Status				
10	RECORD: WH-A Temperature Control Valve Position (If available)				
11	RECORD: WH-B Temperature Control Valve Position (If available)				
12	RECORD: HW Temperature to HX				
13	RECORD: HW Temperature Leaving HX				
14	RECORD: Mixing Valve Setpoint/Actual Leaving Water Temperature				

Sample Plumbing Systems Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: Domestic Hot Water System

2.01 System Enabled - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Domestic Water System is enabled				
2	EXPECTED RESPONSE: Domestic Water Recirculation Pumps are energized manually				
3	EXPECTED RESPONSE: Active Water Heater's circulation pump is energized				
4	EXPECTED RESPONSE: Water Heaters Temperature Control Valve modulates to maintain the LWT Setpoint				
5	EXPECTED RESPONSE: Mixing Valve maintains setpoint				
6	TEST PROCEDURE: Water Heater LWT is above or below setpoint				
7	EXPECTED RESPONSE: Water Heaters Temperature Control Valve modulates to maintain the LWT Setpoint				
8	RECORD: DHWS Leaving WH-A Temperature Setpoint/Actual				
9	RECORD: DHWS Leaving WH-B Temperature Setpoint/Actual				
10	EXPECTED RESPONSE: Mixing Valve maintains setpoint				

2.02 System Disabled - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Domestic Water System is disabled				
2	EXPECTED RESPONSE: Domestic Water Recirculation Pumps are de-energized manually				
3	EXPECTED RESPONSE: Water Heater's circulation pumps are de-energized				
4	EXPECTED RESPONSE: Water Heaters Temperature Control Valves open to bypass				

3.01 System Alarm - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate an alarm from the system				
2	EXPECTED RESPONSE: Alarm is sent to BAS				

Sample Electrical Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: Lighting Controls

1.0 Test Procedure: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	VERIFY A minimum of 20% of occupancy sensors are to be functionally tested. Document room tested and results of device tested.				
2	VERIFY by visual response that:				
3	PROCEDURE Device senses space is occupied and turns lights ON.				
4	PROCEDURE Device senses space is un-occupied.				
5	PROCEDURE Device turns lights off after preset time delay. (10-30 minutes)				
6	PROCEDURE Local switch operates properly, if applicable.				
7	PROCEDURE Device location during time of functional testing is indicated below:				

1.1 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	RECORD Devices installed in the following areas were demonstrated to operate, with any issues noted on the MIL. See 'Comments' section for device location.				
2	Level 1				

1.2 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 2				

1.3 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 3				

1.4 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 4				

1.5 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 5				

1.6 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 6				

Sample Electrical Functional Performance Test

PROJECT:
LOCATION:

SYSTEM/UNIT: Lighting Controls

	Verification	Response	Notes	By	Date/Time
1	VERIFY the following features are provided:				
2	3.5 inch touch screen				
3	On/Off buttons for each group of fixtures				
4	Dimmer for each group of fixtures				
5					

2.1 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	RECORD Device(s) installed in the following areas were demonstrated to operate, with any issues noted on the MIL. See 'Comments' section for additional device location.				
2	Level 1				

2.2 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 2				

2.3 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 3				

2.4 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 4				

2.5 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 5				

2.6 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 6				

FACILITIES COMMISSIONING

Sample Electrical Functional Performance Test

PROJECT:
LOCATION:
PROJECT #:

SYSTEM/UNIT: Emergency Power System/G1

1.0 Load Testing - Emergency Power System/G1

	Verification	Response	Notes	By	Date/Time
1	VERIFY Transfer switches are complete, testing coordinated concurrently with generator testing.				
2	VERIFY Load bank provided is fully rated 0.8PF device.				
3	PROCEDURE: From "cold start", disconnect primary power to all ATS's.				
4	RECORD: Time delay on start.				
5	RECORD: Time taken to reach operating speed.				
6	RECORD: Voltage and frequency overshoot.				
7	RECORD: Time taken to achieve steady state condition.				
8	PROCEDURE: 100% full load test allowed to run for 2 hours. (Intent of NFPA 110 is to use building loads).				
9	RECORD: Voltage, frequency, load current, fuel pressure, oil pressure, and coolant temperature recorded at first load acceptance and in 15 minute intervals thereafter.				
10	PROCEDURE: Restore primary power to each ATS.				
11	RECORD: Generator cooldown and shutdown period.				
12	PROCEDURE: Generator allowed to cool for 5 minutes.				
13	PROCEDURE: Generator started individually and closed to 100% nameplate KW.				
14	RECORD: Cranking time until the prime mover starts and runs.				
15	RECORD: Time taken to reach operating speed.				
16	RECORD: Voltage and frequency overshoot.				
17	RECORD: Time taken to achieve steady state condition.				
18	PROCEDURE: 2-hour 100% load test performed.				
19	RECORD: Voltage, frequency, load current, fuel pressure, oil pressure, and coolant temperature recorded at first load acceptance and in 15 minute intervals thereafter.				

Sample Electrical Functional Performance Test

PROJECT:
LOCATION:
PROJECT #:

SYSTEM/UNIT: Emergency Power System/G1

2.0 Crank Cycle Test - Emergency Power System/G1

	Verification	Response	Notes	By	Date/Time
1	PROCEDURE: Utilize any method recommended by manufacturer to prevent the prime mover from running.				
2	PROCEDURE: Put the control switch into "run" to cause the prime mover to crank.				
3	VERIFY: Starting battery pack is capable of maintaining cranking speed for 75 second cycle per NFPA 110 (15 sec crank, 15 sec rest, 15 sec crank, 15 sec rest, 15 sec crank).				
4	RECORD: Battery voltage at conclusion of test.				

3.0 Generator Control Panel - Emergency Power System/G

	Verification	Response	Notes	By	Date/Time
1	VERIFY the proper operation of each function:				
2	3-position selector switch (run/off/auto)				
3	Local emergency stop button				
4	Push-button reset switch				
5	Voltage adjustment potentiometer				
6	Self-diagnostic capabilities with a readout on a digital display pa				
7	Lamp test switch				
8	Panel illumination lights with switch				
9	Contacts for local and remote common alarm				
10	Verify activation of alarm horn and indicating LED for each alarm and shutdown.				
11	VERIFY the proper operation of each shutdown, alarm, and pre-alarm:				
12	Overcrank shutdown - red				
13	Low coolant temperature alarm - red				
14	High water temperature pre-alarm - amber				
15	High water temperature shutdown - red				
16	Low oil pressure pre-alarm - amber				
17	Low oil pressure shutdown - red				
18	Overspeed shutdown - red				
19	Low fuel main tank				
20	Low coolant level				
21	EPS supplying load				

FACILITIES COMMISSIONING

Sample Electrical Functional Performance Test

PROJECT:
LOCATION:
PROJECT #:

SYSTEM/UNIT: Emergency Power System/G1

3.0 Generator Control Panel - Emergency Power System/G1

	Verification	Response	Notes	By	Date/Time
22	Controls not in auto				
23	High battery voltage				
24	Low cranking voltage				
25	Low battery voltage				
26	Battery charger failure alarm				
27	Ground fault alarm				
28	VERIFY proper operation of each meter and gauge:				
29	Voltmeter				
30	Ammeter				
31	Frequency meter				
32	Power factor				
33	KVAR				
34	KWH				
35	Battery charging voltmeter				
36	Coolant temperature gauge				
37	Oil pressure gauge				
38	Running time meter				
39	Engine RPM				

4.0 Remote Annunciator Panel - Emergency Power System/G1

	Verification	Response	Notes	By	Date/Time
1	VERIFY activation of alarm horn and indicating LED for each al and shutdown:				
2	Overcrank shutdown				
3	Low coolant temperature alarm				
4	High water temperature pre-alarm				
5	High water temperature shutdown				
6	Low oil pressure pre-alarm				
7	Low oil pressure shutdown				
8	Overspeed shutdown				
9	Low fuel main tank				
10	Low coolant level				
11	Controls not in auto				
12	Batt charger AC failure				
13	Ground fault alarm				
14	Lamp test switch				
15	PROCEDURE: Activate remote emergency stop pushbutton				
16	VERIFY: Generator shuts down immediately.				

SAMPLE CONTROL SYSTEM TREND DATA FOR Cx

		Equipment ID / Trending Interval (minutes)													
Point Description	Units	Weather Station	Air Handling Units	Chilled Water System	Condenser Water System	Hot Water System	Air Terminal Unit Space Served	Fan Coil Units	Computer Room Air Conditioner	Exhaust Fan	Unit Heater	Electrical Panels	Domestic Water Heating System	Irrigation System	Lighting Control System
Outdoor Air Dry Bulb Temp	F	15													
Outdoor Air Relative Humidity	%RH	15													
SF VFD Power	kWh		15												
SF Airflow	CFM		15												
SF Airflow Setpoint	CFM		15												
Unit Discharge Air Temp	F		15												
Unit DAT Setpoint	F		15												
Space Humidity	%RH		15				15		15						
Space Humidity Setpoint	%RH		15				15		15						
Humidifier Valve Position	% Open		15												
CHW Return Temp	F		15												
CHW Valve Position	% Open		15					15	15						
HW Return Temp	F		15												
AHU HW Valve Position	% Open		15												
Zone Airflow	CFM						15								
Zone Damper Position	% Open		15				15								
Zone HW Discharage Air Temp	F		15				15								
Zone HW Valve Position	% Open		15				15	15	15						
Space Temperature	F		15				15	15	15		15				
Space Temperature Active Setpoint	F		15				15	15	15		15				
Occupied Status (Sensor or Schedule)	On/Off						15	15	15						
RF VFD Power	kWh		15												
RF Airflow	CFM		15												
Space Differential Static Pressure	in. w.c.		15				15								
Space Differential Static Pressure Setpoint	in. w.c.		15				15								
Outdoor Air Damper Position	% Open		15												
Outdoor Airflow	CFM		15												
Outdoor Airflow Setpoint	CFM														
Duct Static Pressure	in. w.c.														
Duct Static Pressure Setpoint	in. w.c.														
Supply Air CO2	ppm														
Space CO2	ppm						15								
Space Differential CO2 Setpoint	ppm						15								
Bldg Supply Temp	F			15											
Bldg Supply Temp Setpoint	F			15											
System Supply Setpoint	F			15	15	15									
System Supply Temp	F			15	15	15							15		
System Return Temp	F			15	15	15									
System Flow	gpm			15	15	15									
System Capacity	MBh			15	15	15									
System Diff Pressure	psi			15	15	15									
System Diff Pressure Setpoint	psi			15	15	15									
Pump VFD Power	kWh			15	15	15									
Chiller CHW Supply Temp	F			15											
Chiller CHW Return Temp	F			15											
Chiller Evaporator Flow	gpm			15											
Chiller Entering CW Temp	F			15											
Chiller Leaving CW Temp	F			15											
Chiller Power (Typical each compressor)	kWh			15											
Cooling Tower VFD Power (Typical each fan)	kWh				15										
Heat Recovery Chiller HW Return Temp	F					15									
Heat Recovery Chiller HW Supply Temp	F					15									
Heat Recovery Chiller HW Supply Temp Setpoint	F					15									
Boiler Status	On/Off					15							15		
Fan Status	On/Off							15	15	15	15				
Pump Status	On/Off												15		
Exhaust Fan VFD Power	kWh									15					
Illuminance	fc														15
Make-up Water Consumption	gpm													15	
Electric Consumption	kWh											15			
Natural Gas Consumption	cu. ft.					15							15		

SAMPLE TREND REPORT FORMAT FOR Cx

Sample Trend Report is for a typical VAV Box "Forced Trend" of max heating / max cooling over 4-hr period
Trended Points are examples for Report formatting only. Equipment points to be trended will be determined during Cx FPT Scheduling Meeting.

Date / Time	Zone Setpoint (deg F)	Zone Temp (deg F)	Supply Airflow Setpoint (cfm)	Supply Airflow (cfm)	Discharge Air Velocity Pressure (in)	Supply Air Damper Output	Heating Output	Discharge Air Temperature
10/20/20 4:10 AM	80	75.567	150	142.602	0.09452248	45.22485	0	57.07278
10/20/20 4:00 AM	80	76.23032	75	71.92915	0.00709486	34.84291	100	102.8144
10/20/20 3:50 AM	80	75.92749	75	71.92915	0.00709486	34.84291	100	102.1922
10/20/20 3:40 AM	80	75.92749	75	71.92915	0.00709486	34.84291	100	102.1836
10/20/20 3:30 AM	80	75.61987	75	71.92915	0.00709486	33.71024	100	102.1836
10/20/20 3:20 AM	80	75.61987	75	71.92915	0.00709486	33.71024	100	102.1836
10/20/20 3:10 AM	80	75.31226	75	71.92915	0.00709486	33.71024	100	102.1836
10/20/20 3:00 AM	80	75.31226	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 2:50 AM	80	75.00943	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 2:40 AM	80	74.70181	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 2:30 AM	80	74.70181	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 2:20 AM	80	74.3942	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 2:10 AM	80	74.3942	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 2:00 AM	80	74.09138	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 1:50 AM	80	73.78376	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 1:40 AM	80	73.45211	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 1:30 AM	80	73.45211	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 1:20 AM	80	73.14928	75	71.92915	0.00709486	33.71024	100	101.885
10/20/20 1:10 AM	80	72.7888	75	71.92915	0.00709486	33.71024	100	101.5866
10/20/20 1:00 AM	80	72.48597	75	71.92915	0.00709486	34.76664	100	101.8868
10/20/20 12:50 AM	80	72.17355	75	71.92915	0.00709486	34.76664	100	102.1986
10/20/20 12:40 AM	80	71.87074	75	71.92915	0.00709486	33.69927	100	102.1986
10/20/20 12:30 AM	80	71.56792	75	71.92915	0.00709486	33.69927	100	102.4994
10/20/20 12:20 AM	80	70.92865	75	71.92915	0.00709486	33.69927	100	102.4994
10/20/20 12:10 AM	80	70.62102	75	71.92915	0.00709486	34.7197	100	100.9305
10/20/20 12:00 AM	80	70.3134	45	47.4287	-0.01075673	30.61368	0	58.21156
10/19/20 4:10 AM	55	68.63589	75	73.47628	0.006408334	38.46322	45.21756	72.7017
10/19/20 4:00 AM	55	67.97258	119.5859	137.9515	0.05859017	55.18406	0	56.25162
10/19/20 3:50 AM	55	67.97258	120.0941	137.9515	0.05859017	55.18406	0	56.25162
10/19/20 3:40 AM	55	67.97258	125.35	137.9515	0.06225204	57.4519	0	56.25162
10/19/20 3:30 AM	55	67.97258	127.7748	137.9515	0.06911814	57.4519	0	56.25162
10/19/20 3:20 AM	55	67.97258	130.4174	137.9515	0.06911814	58.50766	0	56.25162
10/19/20 3:10 AM	55	67.97258	132.3511	137.9515	0.07140672	58.50766	0	56.25162
10/19/20 3:00 AM	55	67.97258	133.8609	137.9515	0.07140672	59.61676	0	56.25162
10/19/20 2:50 AM	55	67.97258	142.378	137.9515	0.08536768	63.46486	0	56.25162
10/19/20 2:40 AM	55	67.97258	144.0649	137.9515	0.08536768	62.02474	0	56.25162
10/19/20 2:30 AM	55	67.97258	149.5942	137.9515	0.09658229	65.4512	0	56.25162
10/19/20 2:20 AM	55	68.27541	150	137.9515	0.09658229	66.84628	0	56.25162
10/19/20 2:10 AM	55	68.27541	150	137.9515	0.09658229	68.91989	0	56.25162
10/19/20 2:00 AM	55	68.27541	150	137.9515	0.09658229	70.00221	0	56.25162
10/19/20 1:50 AM	55	68.61186	150	137.9515	0.09658229	72.25705	0	56.25162
10/19/20 1:40 AM	55	68.61186	150	137.9515	0.09658229	72.25705	0	56.25162
10/19/20 1:30 AM	55	68.91467	150	137.9515	0.09658229	72.25705	0	56.25162
10/19/20 1:20 AM	55	68.91467	150	137.9515	0.09658229	73.39082	0	56.25162
10/19/20 1:10 AM	55	69.2175	150	137.9515	0.09658229	73.39082	0	56.25162
10/19/20 1:00 AM	55	69.2175	150	137.9515	0.09658229	73.39082	0	56.25162
10/19/20 12:50 AM	55	69.52512	150	137.9515	0.09658229	73.39082	0	56.54948
10/19/20 12:40 AM	55	69.83273	150	137.9515	0.09658229	73.39082	0	56.54948
10/19/20 12:30 AM	55	70.44318	150	137.9515	0.09658229	73.39082	0	56.84668
10/19/20 12:20 AM	55	70.77484	150	137.9515	0.09658229	74.4721	0	57.74506
10/19/20 12:10 AM	55	71.39008	150	137.9515	0.09658229	74.4721	0	58.65091
10/19/20 12:00 AM	55	72.4331	45	44.99492	-0.008468151	33.65736	0	59.27457

END OF SECTION 019113

SECTION 019115 - BUILDING ENCLOSURE COMMISSIONING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section includes the Commissioning (Cx) requirements for Building Enclosure systems.

1. The Building Enclosure Commissioning requirements are separate from, and in addition to, the Building Systems Commissioning requirements in Section 019113. The Construction Manager and Subcontractors are required to participate in each of the Commissioning processes.
2. The 019115 Building Enclosure Commissioning Agent (BECxA) and 019113 Commissioning Agent (CxA) will provide separate documentation for each Commissioning process.

1.2 RELATED DOCUMENTS

A. The work under this section is subject to requirements of the Contract Documents, including the Owner's General Conditions and articles of the Construction Manager's General Conditions.

B. This section includes the commissioning requirements for the Building Enclosure systems.

1. Refer to Section 019117 for Building Enclosure Functional Performance Testing.
2. The commissioning requirements for the building enclosure systems given in this section are entirely separate from, and in addition to, the Building Systems Commissioning specified in specification section 019113.
3. The Construction Manager, Contractors, Sub-contractors and Suppliers are required to participate in both commissioning processes as required by sections 019113 General Commissioning Requirements and 019115 Building Enclosure Commissioning.
4. The 019113 Commissioning Agent (CxA) and 019115 Building Enclosure Commissioning Agent (BECxA) will provide separate documentation for each commissioning process.

C. Specific building enclosure commissioning requirements are given in this specification. The following specification sections are related to the commissioning work specified in this section:

1. Integrated Exterior Mockups: Refer to 014339
2. Building Systems Commissioning: Refer to 019113
3. Building Enclosure Functional Performance Testing: Refer to 019117
4. Basic Concrete Requirements: Refer to Division 03
5. Basic Masonry Requirements: Refer to Division 04
6. Basic Waterproofing, Roofing, Cladding, Air Barrier, Insulation Requirements: Refer to Division 07
7. Basic Fenestration Systems Requirements: Refer to Division 08

D. Reference standards to be included as part of the building enclosure commissioning process include the following:

1. National Institute of Building Sciences 'Building Enclosure Commissioning Process BECx', Guideline 3-2012.

2. ASTM E2813-18, 'Standard Practice for Building Enclosure Commissioning'
3. ASTM E2947-21a, 'Standard Guide for Building Enclosure Commissioning'

1.3 GENERAL DESCRIPTION

A. Building Enclosure Commissioning is a systematic process of validating and verifying all building enclosure systems responsible for environmental separation perform interactively according to the Owner's Project Requirements. The Building Enclosure Commissioning process is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify and document installation and performance of building enclosure materials and systems.
2. Endeavor to provide the Owner with functional Building Enclosure systems that meet the Project Requirements.

B. Commissioning does not take away from or reduce responsibility of system designers or installing contractors to provide a finished and fully functioning product per the contract documents.

C. This section shall in no way diminish the responsibility of Division 03, 04, 05, 07, and 08 Contractors, Subcontractors, and Suppliers in performing all aspects of work and testing as outlined in the Contract Documents. Any requirements outlined in this section are in addition to requirements outlined in Division 03, 04, 05, 07, and 08.

1.4 ABBREVIATIONS

A. The following are common abbreviations used in this Section (definitions are found further in this Section):

1. A/E – Architect and Design Engineers
2. BECx – Building Enclosure Commissioning
3. BECxA – Building Enclosure Commissioning Agent
4. BECT – Building Enclosure Commissioning Team
5. BETA – Building Enclosure Testing Agency
6. BECx Plan – Building Enclosure Commissioning Plan
7. FPT – Functional Performance Test
8. CM – Construction Manager
9. CT – Commissioning Team
10. CxA – Commissioning Agent for Building Systems - Refer to Section 019113
11. O&M – Operations & Maintenance

1.5 DEFINITIONS

A. Approval: Acceptance that a material or system has been properly installed and is functioning in tested modes according to the Contract Documents.

B. Architect/Engineer (A/E): Prime consultant (architect) and sub-consultants who comprise the design team, generally the Architect of Record and any Design Sub-consultants.

C. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions, and methods chosen to meet intent.

D. Building Enclosure Commissioning Agent (BECxA): Contracted to Owner through the CxA. BECxA directs and coordinates day-to-day Building Enclosure Commissioning activities independently from CxA.

E. Building Enclosure Commissioning Plan (BECx Plan): Overall plan developed after bidding that provides structure, schedule, and coordination planning for the Building Enclosure commissioning process.

F. Building Enclosure Commissioning Team (BECT): See 1.7 A.

G. Building Enclosure Testing Agency (BETA): BETA will be represented by or contracted to the BECxA and is responsible for executing building enclosure functional performance testing under the direction of the BECxA.

H. Building Enclosure Functional Performance Test (FPT): Test of performance of building enclosure materials and systems. Systems are tested under various simulated environmental conditions, such as air or water leakage under pressure differential. Refer to Section 019117.

I. Commissioning (Cx) Database - A “cloud-based” process management platform provided by the CxA utilized to execute the Commissioning process.

J. Commissioning Agent (CxA): Commissioning Agent for Building Systems; refer to Section 019113. Contracted to Owner. CxA directs and coordinates day-to-day Building Systems Commissioning activities independently from BECx activities. CxA reports directly to Owner.

K. Commissioning Observation: Any condition identified by the BECxA that adversely affects the commissionability, operability, maintainability or functionality of a system, equipment or component. Any condition that is in conflict with the project OPR, Contract Documents, performance requirements, manufacturer requirements, and/or accepted industry standard practices of the installed systems and components. (See also – Deficiency, Master Issues Log)

L. Commissioning Plan: Overall plan developed after bidding that provides structure, schedule and coordination planning for Commissioning process.

M. Contract Documents: Contract documents include design and construction contracts, price agreements and procedure agreements. Contract Documents also include all final and complete drawings, specifications and all applicable contract modifications or supplements.

N. Contractor: Contractor or Subcontractors responsible for furnishing and installation of building components and systems.

O. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents (that is, does not perform properly or is not complying with design intent).

P. Functional Performance Test (FPT): Test of function and operation of components and systems. Systems are physically tested to verify various performance requirements are met (resistance to water penetration, air leakage rate, adhesive strength, etc.). Refer to 019117 Building Enclosure Functional Performance Testing and testing requirements in related specifications.

Q. Master Issues Log (MIL): On-going list tracking commissioning observations and BECT responses and resolution.

R. Mockup: On-building structure which includes representative portions of building enclosure systems, assemblies, and components. Mockups shall be constructed, tested, and reviewed prior to commencement of building enclosure construction. Refer to specification 014339 Integrated Exterior Mockups.

S. Owner's Project Requirements (OPR): A written document that details the project requirements and the expectations of how the building and its systems will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

T. Specifications: Construction specifications of Contract Documents.

U. Sub-contractor: Contractors of CM, and their Sub-contractors, who provide and install building enclosure components and systems.

V. Warranty Period: Warranty period for entire project, including equipment components.

1.6 RELATED WORK

A. Specific building enclosure commissioning requirements are given in this specification. The following specification sections are related to the commissioning work specified in this section:

1. Building Systems Commissioning: Refer to 019113
2. Building Enclosure Functional Performance Testing: Refer to 019117
3. Basic Concrete Requirements: Refer to Division 03
4. Basic Masonry Requirements: Refer to Division 04
5. Basic Waterproofing, Roofing, Air Barrier, Insulation Requirements: Refer to Division 07
6. Basic Fenestration Systems Requirements: Refer to Division 08

1.7 COORDINATION

A. Building Enclosure Commissioning Team: Members of the Building Enclosure Commissioning Team (BECT) will consist of:

1. Architect and Design Engineers (A/E)
2. Building Enclosure Commissioning Agent (BECxA)
3. Building Enclosure Testing Agent (BETA)
4. Division 03, 04, 07, 08 Contractors who provide and install the systems to be commissioned.
5. Any other Contractors or Subcontractors who provide and install the systems to be commissioned.
6. Commissioning Agent (CxA)
7. Construction Manager (CM)
8. Owner(s) (OR)
9. Representatives of the Facility User and Operation and Maintenance Personnel.
10. Systems Suppliers and Vendors.

B. Management: Owner will contract services of the CxA. The BECxA will direct and coordinate building enclosure commissioning activities and report to the CxA and OR. All members of the

Building Enclosure Commissioning Team shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.

C. Kick-Off Meeting: BECxA will plan, schedule and conduct a Building Enclosure Commissioning Kick-Off Meeting. Membership and responsibilities of the BECT will be clarified at this meeting. BECx Kick-Off Meeting will be conducted no later than 30 days prior to initial installation of any commissioned systems on-site. CxA will distribute meeting minutes to all parties.

D. Scheduling: BECxA will work with the BECT to establish required commissioning activities to incorporate in preliminary commissioning schedule. The CM will integrate commissioning activities into a master construction schedule. Necessary notifications are to be made in a timely manner in order to expedite the commissioning process.

E. Project Phasing and Project Substantial Completion:

1. Phased completion of the project construction is anticipated. The commissioning processes described herein will be completed for each phase of work.
2. All BECxA work with the exception of the following must be completed for each project phase prior to Owner move-in/occupancy.

a. The following BECx work will be completed after Owner move-in/occupancy:

1) Compilation and delivery of Final Commissioning Report.
2) End of Warranty Review Meeting

PART 2 - PRODUCTS / COMMISSIONING DOCUMENTATION

2.1 COMMISSIONING (Cx) DATABASE

A. The BECx process will be executed utilizing a “cloud-based” process management Cx Database provided by the CxA. Cx Database is accessed by authorized users using any device running an HTML-5 internet browser (e.g., PC, laptop, tablet, phone) or by an operating system specific (e.g., iOS) application downloaded from corresponding app store.

B. Cx Database platform will be autonomous from any other database or web-based information platform utilized by the Construction Team throughout project construction.

C. CxA will provide the Commissioning Team with web access to the Cx Database during the Commissioning process. The CM/Contractors will complete the scoped Commissioning tasks indicated in other Sections of this specification in the Cx Database (e.g., completion of Commissioning activities, such as providing documentation of BECx Master Issues Log deficiency item corrections).

2.2 BUILDING ENCLOSURE COMMISSIONING PLAN

A. BECxA will develop overall plan for execution of the BECx Process.

B. The BECx Plan will contain:

1. Overview of the commissioning process.

2. Listing of major Commissioning milestones for coordination and inclusion in the master construction schedule.
3. List of BECT members and roles and responsibilities.
4. Description of management and communication for the commissioning process.
5. Master Systems List (list of commissioned component and systems).
6. Functional Performance Test Plan with test procedures and requirements for each commissioned system. The initial Cx Plan will not include the FPTs. Final FPTs will be developed in the Cx Database after related submittals are approved by the A/E.
7. Operation & Maintenance Data Matrix.
8. Warranty Matrix.
9. Owner Training Matrix.

C. The BECx Plan will be delivered to the BECT in electronic format (Adobe PDF file searchable from the Table of Contents).

2.3 MASTER ISSUES LOG (MIL)

A. Any issues noted by BECxA are tracked in a Master Issues Log (MIL). The MIL will be developed in and accessed/tracked through the Cx Database.

2.4 COMMISSIONED SYSTEMS SUBMITTALS AND O&M DATA

A. CM shall provide CxA with documentation required for Commissioning work. At minimum, documentation shall include: Requirements as described in Section 013000, O&M data, performance data, any performance test procedures, manufacturer's installation manuals, manufacturer's laboratory testing documentation, and Contractor or Owner's-contracted testing documentation related to the systems to be commissioned.

2.5 SITE VISIT REPORTS

A. BECxA will conduct regular site visits to complete scoped commissioning work. BECxA will provide a report for each site visit to members of the BECT.

B. BECxA Site Visit Report will include the following:

1. Attendees and purpose of site visit.
2. Observations regarding commissioned systems and results of completed commissioning work.
3. "Next Steps" section documenting BECx process status and upcoming BECx work / site visits.
4. Current Master Issues Log (MIL).
5. Picture Report (where applicable).

2.6 CM / CONTRACTOR OWNER TRAINING PLAN

A. CM/Contractors/Vendors will provide complete Owner training in Operation and Maintenance of all commissioned systems/equipment required under contract per specifications.

B. CM with assistance from responsible Contractors/Vendors shall develop a detailed program for Owner Training per 017000 Execution and Closeout Procedures and 017900 Demonstration and Training.

2.7 FUNCTIONAL PERFORMANCE TESTS (FPT)

A. BECxA will develop the Functional Performance Testing procedures from the Contract Documents and A/E approved submittals. The Functional Performance Test Procedures will be initially described in the BECx FPT Plan and developed in the Cx Database. The Functional Performance Tests will be executed by the BETA with support from the CM/Contractors. The BECxA will witness Functional Performance Tests and document the results in the Cx Database. Reference Specification 019117 Building Enclosure Functional Performance Testing for requirements on tests performed by the BETA.

B. Development of Test Procedures:

1. The purpose of any given specific test is to verify and document compliance with stated criteria of acceptance given on test form. BECxA shall develop specific test procedures based on standard industry test methods (AAMA, ASTM, etc.). Prior to execution, BECxA shall provide a copy of test procedures to Contractors. Contractor will review tests for feasibility, safety, and warranty protection. BECxA shall submit tests to Owner, CM and A/E and other Commissioning team members for review.
2. Test procedures will indicate general specimen type to be tested. Selection of actual test specimens will be selected by the BECxA and BECT on the day of testing from the available specimens identified by the Contractors as ready for testing on the Certificate of Readiness.
3. Test procedure forms developed by the BECxA will include (but not be limited to) the following information:

    a. System and equipment or component name(s)
    b. General location or specimen type
    c. Date
    d. Project name
    e. Participating parties
    f. Specific specified parameters being verified
    g. Test setup parameters
    h. Test procedures
    i. Results section to document test results and observations
    j. Section for comments

4. Specific FPT items may be added, modified or deleted in the BECx plan delivered to the CT to reflect the final construction document requirements. CM and Contractors shall review final construction documentation for applicable details and specifications related to equipment to be commissioned to fully ascertain all the FPT requirements.

2.8 CERTIFICATE OF READINESS FOR FUNCTIONAL PERFORMANCE TESTS (FPT)

A. BECxA will provide a Certificate of Readiness to be signed by the CM, Contractors and Equipment Vendors/Suppliers (where appropriate) as a prerequisite for scheduling of BECx FPTs. Completed Certificate of Readiness should be received two weeks prior to anticipated testing date.

B. The Certificate of Readiness will include the following:

1. Project building area
2. Area for CM to indicate FPTs to be scheduled and specimens (e.g. specific window openings) that are ready for testing.
3. Sign-off for CM, Contractors and Vendors (where appropriate) indicating readiness for associated FPTs to be scheduled.
4. Sign-off for CM that test accommodations required by specification 019117 are provided.

C. The intent of this certificate is for the CM, Contractors and other installers to document ("sign-off") that the equipment/systems are installed per the contract document requirements and are ready for FPT.

D. BECxA and BETA will not schedule tests until completed Certificates of Readiness are received. CM shall maintain free and clear access to all test areas, including exclusion and removal of interior finishes if necessary for observation of potential water leakage into concealed cavities, until testing is complete and satisfactory performance is achieved.

2.9 FINAL COMMISSIONING REPORT

A. The BECx Final Commissioning Report will include:

1. Executive Summary including:

   a. List of Commissioned Equipment/Systems.
   b. List of participants and roles.
   c. Summary of the completed Commissioning activities.
   d. Evaluation regarding status of issue resolution.

2. Design Phase BECx Documentation.
3. Master Issues Log.
4. Site Visit Reports.
5. BECxA executed Functional Performance Tests.
6. Sections will be provided for the following information to be inserted later:

   a. End of Warranty Meeting Minutes

PART 3 - EXECUTION

3.1 COMMISSIONING OVERVIEW

A. The following provides a brief overview of typical Building Enclosure Commissioning tasks during construction and general order in which they occur:

1. BECxA develops project specific Building Enclosure Commissioning Plan in the Cx Database including Functional Performance Test procedures. Building Enclosure Commissioning Team members are provided web access to the Cx Database for review of the Cx Plan prior to BECx Kick-Off meeting.
2. Commissioning during construction begins with a Kick-Off Meeting conducted by BECxA where membership of Building Enclosure Commissioning Team is established, and

responsibilities reviewed. The Building Enclosure Commissioning Plan is reviewed during this meeting.

3. BECxA schedules subsequent meetings as necessary to plan, coordinate and schedule Commissioning activities. Deficiencies and problem resolution will also be discussed at these meetings.
4. CM submits copies of submittals for all systems to be commissioned in Procore software to BECxA for review concurrently with A/E review. BECxA reviews submittals and returns review comments in Procore software.
5. BECxA revises Cx Plan if required based on final A/E approved submittals in Procore software.
6. Contractors install commissioned systems.
7. CM/Contractors develop initial outline Owner Training Program and submit to CT for review.
8. CxA makes regular site visits to observe commissioned system installations. Installations are reviewed against the design drawings and specifications, system manufacturer's requirements, and approved submittals.
9. Any issues noted by BECxA are tracked in a Master Issues Log (MIL) on the Cx Database platform. CM/Contractors correct issues noted by BECxA and update MIL in Cx Database for BECxA verification of issue corrections.
10. CM and Contractors coordinate overall schedule of systems installation and notify the BECxA when specimens ready to test by submitting completed Certificates of Readiness. CM and Contractors submit schedules to BECxA so that BETA may schedule and coordinate site visits and testing.
11. BETA completes testing as required by specification 019117 with support from CM and Contractors. BETA provides documentation of completed FPTs.
12. CxA conducts Commissioning Functional Testing Schedule Meetings with the Commissioning Team to establish a coordinated approach to the integration of the Functional Performance Testing activities within the Master Construction Schedule.
13. Items of non-compliance in material, installation or set-up will be corrected and system shall be retested at Contractor expense.
14. CM/Contractors execute Owner Training exercises per Owner Training Plan.
15. BECxA issues Final Commissioning Report.
16. CxA participates in End of Warranty Review meetings with facility maintenance staff to review systems performance. An updated Warranty Phase Issue Log shall be generated, and the Contractor shall resolve all issues determined by the CT to be subject to Warranty requirements.

3.2 SYSTEMS TO BE COMMISSIONED

A. Building Enclosure Systems to be commissioned:

1. Below Grade Waterproofing, Vapor Barriers, Air and Moisture Barriers, Exterior Cladding, Fenestration, and Roofing Systems responsible for providing the following functions:

    a. Air control
    b. Vapor control
    c. Insulation/thermal protection
    d. Waterproofing

3.3 RESPONSIBILITIES OF COMMISSIONING TEAM MEMBERS

A. Architect/Engineer (A/E)

1. Document design intent of systems. Respond to any issues developed during the commissioning process that may require clarification of design intent.
2. Develop mockup drawings as required for testing within specification section 014339 and 019117.
3. Review and incorporate Building Enclosure Commissioning specification section and Building Enclosure Functional Performance Testing specification section into the construction documents.
4. Attend BECx meetings as requested.
5. Provide construction documents electronically.
6. Review and respond to/incorporate BECxA comments made during design and submittal/shop drawing reviews.
7. Assist in dispute resolution regarding building enclosure systems regarding confirmation of design intent and specification requirements.
8. Review BECxA reports and respond to A/E items.

B. Building Enclosure Commissioning Agent (BECxA)

1. Facilitate cooperation of BECT in Commissioning work.
2. Develop and update BECx plan as necessary.
3. Develop the BECx and Building Enclosure FPT specification sections.
4. Review pertinent building enclosure related submittals and shop drawings. Provide submittal review comments to OR and A/E for inclusion in the submittal comments returned to the CM.
5. Conduct BECx kick-off meeting to review BECx Plan and responsibilities of each member of the BECT.
6. Participate in Contractors' pre-installation/coordination meetings for commissioned systems where specified.
7. Review initial outline Owner Training Program developed by CM/Contractors.
8. Perform construction observation visits to observe and document installation of the building enclosure materials, systems, and components, and observe representative field testing.
9. Perform and document functional performance field testing performed by BETA.
10. Witness building enclosure testing performed by others as required by the Contract Documents.
11. Issue reports documenting the BECx process and activities.
12. Maintain the BECx MIL in the Cx Database. Review and respond to Contractors' responses and documentation verifying corrective actions.
13. Attend and chair BECT meetings as required.
14. Provide the final BECx record.

C. General Contractor (CM)

1. The CM leads the commissioning process for the construction team and facilitates cooperation of Contractors in executing and completing the commissioning work. In addition to the specific CM commissioning roles and responsibilities specified herein, the CM is ultimately responsible for ensuring that the Contractor commissioning roles and responsibilities given in other Sections of this specification are executed and completed as specified.
2. Attend BECx coordination/kick-off meetings and other commissioning team meetings. The CM is responsible for all coordination items with Subcontractors.
3. Incorporate and periodically update commissioning activities into the construction schedule.
4. Notify BECT of schedule updates and onsite activities affecting BECx tasks.
5. Facilitate cooperation of Contractors in commissioning work.

6. Submit copies of initial submittals in Procore software to A/E and BECxA for review. Provide final A/E approved submittals in Procore software to BECxA for record purposes.
7. Review and respond to BECxA's submittal review comments.
8. Review BECx Plan, Pre-Functional Checklists, and FPT procedures.
9. Attend BECx Kick-Off Meeting and other BECT Meetings.
10. Verify building enclosure materials and assemblies are ready for functional performance testing. Submit completed FPT Certificate of Readiness to BECT and coordinate scheduling of Building Enclosure FPT with the BECxA and BETA at least two weeks prior to testing.
11. Ensure resolution of non-compliance and deficiencies in construction or test results. Provide written responses and documentation of completion from the appropriate subcontractors and record responses in the MIL. Documentation includes photographs of addressed items prior to concealment by other components.
12. Provide letters of compatibility for adjacent building enclosure materials and assemblies.
13. Provide Test Accommodations required in specification 019117 Building Enclosure Functional Performance Testing.
14. Schedule, coordinate and assist BECT in FPTs. Attend and participate in FPTs as required to insure Contractor and Vendor participation and completion of scheduled FPT activities. At a minimum, the CM should be present at start and completion of daily FPT activities to ensure Contractor/Equipment Vendor participation, coordination, and completion of Functional Testing work.
15. Facilitate all repairs and retesting of failed functional performance testing and pay for all associated costs of retesting and additional testing including costs related to testing observation and documentation by the BECxA.
16. Following failed field testing, provide a plan of repairs to be performed to the BECT for review. A/E shall approve plan of repairs prior to implementation and retesting. All repairs performed to facilitate successful testing must be approved by the A/E and performed comprehensively throughout project.
17. Verify Contractors correct deficiencies identified during Functional Performance Testing.
18. Develop, with cooperation of Sub-Contractors/Vendors, detailed Owner Training Program. Submit initial outline Owner Training Program to BECT for review within 60 days of completion of submittal process (i.e., all equipment/systems approved by A/E). Revise Owner Training Program as required based on BECxA review comments.
19. CM coordinates training sessions and executes training per Owner Training Program through Contractors.
20. Provide all warranty, operations, and maintenance documentation for all commissioned building enclosure systems, materials, and components to the BECxA in Procore software.
21. Schedule, coordinate and attend the End of Warranty Review Meetings to review system/equipment performance. Correct any deficiency issues noted during Warranty Period per the Project Warranty Process.

D. Contractors/Vendors

1. Review Commissioning Plan and building enclosure related specification sections.
2. Provide project-specific submittals/shop drawings as required by the project specifications that clearly indicate how each system is interfaced with adjacent systems. All typical and project-specific interfaces with adjacent systems must be detailed accurately.
3. Provide letters of compatibility for adjacent building enclosure materials and assemblies.
4. Attend BECx coordination/kick-off meetings and other commissioning team meetings.
5. Prepare Owner Training Program with CM where required by specifications.
6. Address all applicable observations in the MIL.

7. Provide written responses and documentation of completion of addressed items as directed by CM to the Cx Database. Documentation includes photographs of addressed items prior to concealment by other components.
8. Attend all required building enclosure functional performance testing and assist BETA in diagnosing testing failures as requested.
9. Ensure installed work is complete, is in compliance with Contract Documents, and is ready for Functional Performance Testing. Notify CM that systems are ready for Functional Performance Testing and coordinate with CM to submit completed FPT Certificate of Readiness two weeks prior to anticipated test date.
10. Correct deficiencies identified during Functional Performance Testing.
11. Provide warranty, operations, and maintenance documentation for all commissioned building enclosure systems, materials, and components to the CM.
12. Participate in the End of Warranty Review Meetings to review system/equipment performance. Correct any deficiency issues noted during warranty period per the Project Warranty Process.

E. Building Enclosure Testing Agency (BETA)

1. Attend BECx coordination/kick-off meetings.
2. Provide technicians and equipment to complete mockup and field FPTs as required in specification 019117 Building Enclosure Functional Performance Testing.
3. Prepare and submit reports at the conclusion of each test.
4. Perform diagnostic testing, retesting, and/or additional testing due to failed tests and prepare corresponding reports.

3.4 BUILDING ENCLOSURE COMMISSIONING TEAM (BECT) MEETINGS

A. BECx meetings will be held periodically as determined by the BECxA.

B. Discussions held in BECx meetings shall include, but not be limited to, system/materials, mockup/field progress, scheduling, testing, documentation, deficiencies, and problem resolution.

3.5 REPORTING

A. BECxA will regularly communicate with members of Commissioning team, keeping them apprised of Commissioning progress. The BECxA will provide periodic status reports to Owner, A/E, CM, and CxA.

B. BECxA will provide reports for site visits to Owner and CM. Site Visit Reports will include BECx Master Issues Log documenting non-compliance and deficiency items.

C. The BECxA shall submit non-compliance and deficiency reports Owner, A/E, CM, and CxA.

D. The BECxA shall provide a Final BECx Report to Owner.

3.6 SUBMITTAL REVIEWS

A. A/E or CM shall provide BECxA with documentation required for commissioning work. All building enclosure related submittals and shop drawings as required by the specifications shall be provided to the BECxA for review and comment.

B. The BECxA shall review building enclosure related submittals and shop drawings prior to or concurrent with the A/E for conformance as it relates to BECx such that the BECxA comments can be incorporated into the returned submittal.

C. The contractor(s) shall review and address all exterior enclosure related submittal and shop drawing review comments. Revised shop drawing details based on submittal review comments shall be clearly marked on the shop drawing resubmittal to indicate where and what changes have been made. Submittal and shop drawing review comments and responses shall be tracked by the BECxA.

D. The BECxA review of submittals and shop drawings does not substitute for or alter the responsibility of the A/E to review submittals and/or shop drawings for compliance with the project requirements. Final approval of submittals and shop drawings rests solely with the A/E.

E. CM shall provide the final A/E approved O&M data for all commissioned equipment/systems to the CxA in Procore software for record purposes.

3.7 BUILDING ENCLOSURE FUNCTIONAL PERFORMANCE TESTING

A. Refer to Section 019117 - Building Enclosure Functional Performance Testing.

3.8 DOCUMENTATION, NON-CONFORMANCE AND RESOLUTION

A. Documentation:

1. The BECxA shall submit observation reports to Owner, A/E, CM, and CxA and log commissioning observations in the Master Issues Log (MIL).

B. Non-Conformance:

1. Deficiency or non-conformance issues observed during regular site visits and testing visits will be noted and reported to the CM, A/E, and Owner.
2. Corrections of deficiencies identified and immediately repaired by Contractors during site observations and testing may be documented by the BECxA.
3. Deficiencies are handled in the following manner:

    a. When there is no dispute on deficiency and Subcontractor accepts responsibility for remedial action:

        1) BECxA documents deficiency and Subcontractor response and intentions. BECxA submits report and MIL to Owner, A/E, CM, and CxA. Copy is provided to Subcontractor by CM.
        2) Subcontractor corrects deficiency and provides written response and/or documentation on the MIL that the deficiency has been addressed.

    b. When there is a dispute about a Deficiency Issue, regarding whether it is a deficiency or who is responsible:

        1) BECxA documents deficiency and Contractor’s response. BECxA submits observation report and MIL to Owner, A/E, CM, and CxA. Copy is provided to Subcontractor by CM.

2) CM facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final Acceptance authority is with the Owner/Owner.
3) CM documents resolution process.
4) Once interpretation and resolution has been decided, appropriate party corrects deficiency and provides written response and/or documentation on the MIL that the deficiency has been addressed.

C. Costs for BECx MIL Issue Corrections and FPT retesting:

1. Cost for Contractor to correct and retest any FPT deficiency item, if they are responsible for deficiency, will be theirs. If Contractor is not responsible, cost recovery for retesting will be negotiated with CM.
2. BECx MIL issue verifications will not be scheduled until Contractor responsible for issue correction updates issue for “Recheck” in Cx Database. If any BECx MIL issue marked for “Recheck” in the Cx Database is found to remain uncorrected by BECxA on recheck, the CM will pay BECxA labor and expenses for any issue reverifications at a rate of $5000 per man-day. BECxA will provide a man-hour estimate for any required issue reverifications. CM must pay Cx MIL issue reverification costs to BECxA in advance for BECxA to schedule Cx MIL issue reverification site visits.
3. FPTs will not be scheduled without signed Certificate of Readiness from CM and Contractors confirming that the work is “complete” and ready for testing. If any portion of the system fails to function as designed, the CM will pay BECxA labor and expenses for any required FPT retesting at a rate of $5000 per man-day. BECxA will provide a man-hour estimate for any required FPT retesting. CM must pay retesting costs to BECxA in advance for BECxA to schedule FPT retesting site visits.

D. Costs for BETA and BECxA Functional Performance Additional Testing:

1. Cost for Contractor to correct and retest any PFC or FPT deficiency item, if they are responsible for deficiency, will be theirs. If Contractor is not responsible, cost recovery for retesting will be negotiated with Contractor.
2. Additional Services for BECxA to complete any Functional Performance Testing during Owner move-in or after Owner occupancy (regardless of whether the testing was attempted prior to that point or not) will be paid for by the CM at a cost of $5000 per man-day. CM must pay testing costs to BECxA in advance for BECxA to schedule testing site visits during Owner move-in or after Owner occupancy.

E. Approval:

1. BECxA notes each test result on test form. BECxA recommends acceptance of each test to Owner. A/E and Owner provide formal approval of FPT. The Owner gives final approval, providing a signature to CM and Contractor.

3.9 TRAINING OF OWNER PERSONNEL

A. CM/Contractors/Vendors will provide complete training in operation and maintenance of systems if required in the Contract Documents.

B. CM and Contractors will be responsible for

1. Developing Owner Training Program.

2. Scheduling of Owner Training with Owner and Contractors. Owner Training Schedule will be provided to BECxA to allow BECxA to schedule site visits to attend a sampling of the training sessions.
3. Execution of Owner Training.
4. Documentation of completed Owner Training.

C. BECxA will monitor the completion of the Owner Training as follows:

1. BECxA will review Owner Training Program submitted by CM.
2. BECxA will attending a sampling of the Owner Training sessions and review the final executed Owner Training Program documentation.

D. General sequencing of the development of the Owner Training Program and completion of the Owner training is as follows:

1. BECxA will review the Owner training requirements (including preparation of Owner Training Program) with the CM/Contractors at the Commissioning Kick-Off meeting.
2. CM will prepare an outline of the Owner Training Program within 60 days of completion of submittal process (i.e., all equipment/systems approved by A/E). Submit Owner Training Program outline to BECT for review.
3. Schedule for Owner Training sessions will be reviewed and updated as required throughout the project construction by BECT at contractor progress meetings (attended by BECxA during periodic site visits). CM will submit final Owner Training Schedule to BECT 30 days prior to start of training exercises to allow CxA sufficient time to schedule site visit trips to witness a sampling of the Owner training exercises.
4. Contractors/vendors will execute training exercises per Training Program.
5. CM will submit a copy of the final executed Owner Training Program and Owner Training Manuals including all training documentation (sign-in sheets, handouts, training DVDs, etc.) to BECxA on completion of Owner Training exercises (BECxA copy is in addition to any copies required by other specifications for Owner use).

3.10 END OF WARRANTY PERIOD MEETING

A. CT will participate in an End of Warranty Period Meeting with the Owner and O&M staff to review the facility and its performance. The End of Warranty Period meeting will be held 10-11 months into the one-year warranty period.

B. The End of Warranty Review meeting shall address:

1. Any outstanding construction deficiencies.
2. Any deficiencies that were noted by the operations staff during the warranty period.
3. Any problems noted by the operations staff related to operating and maintaining the facility as originally intended.

C. CxA will provide a written report for the Warranty Period Meeting. Report will document the process for resolution of all outstanding issues.

1. Outstanding issues noted during the Warranty Period Meeting will be assigned by the CM to the appropriate Contractor for correction.
2. CM/Contractor will correct the issue and notify the Owner and CxA of correction.

END OF SECTION 019115

SECTION 019117 - BUILDING ENCLOSURE FUNCTIONAL PERFORMANCE TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes functional performance testing requirements for the Building Enclosure systems that will be performed by the building enclosure testing agency as part of the building enclosure commissioning process.

1.2 RELATED DOCUMENTS

A. The work under this section is subject to requirements of the Contract Documents, including the Owner's General Conditions and articles of the Construction Manager's General Conditions.

B. Specific building enclosure testing requirements are given in this specification. The following specification sections are related to the testing work specified in this section and may include additional testing requirements beyond those included in this specification:

1. Integrated Exterior Mockups: Refer to 014339
2. Building Systems Commissioning: Refer to 019113
3. Building Enclosure Commissioning: Refer to 019115
4. Basic Concrete Requirements: Refer to Division 03
5. Basic Masonry Requirements: Refer to Division 04
6. Basic Waterproofing, Roofing, Cladding, Air Barrier, Insulation Requirements: Refer to Division 07
7. Basic Fenestration Systems Requirements: Refer to Division 08

PART 2 - PRODUCTS

2.1 TESTING AGENCY

A. The Building Enclosure Testing Agency (BETA) will be the same entity as the building enclosure commissioning agent (BECxA) for this project and will perform the testing defined in this specification.

B. The building enclosure Functional Performance Testing (FPT) included within this specification is performed by the BETA under the direction of the Owner and BECxA. Testing outside of this specification is not the responsibility of the BETA and is to be performed by others as required in the Contract Documents.

C. The BETA shall be responsible for the applicable specified testing outlined herein. The Construction Manager is responsible for any costs associated with retesting and additional testing, including costs related to observation and documentation of retesting and additional testing by the BECxA.

2.2 TEST ACCOMMODATIONS

A. Construction Manager shall provide the following to the BETA to accommodate testing:

1. Access to the interior and exterior sides of the enclosure assemblies, including equipment and operators as needed (i.e., lifts, swing stages, fall protection systems, and/or scaffolding with trained operators to access the interior and exterior).
2. Water sources with standard garden hose connection within 150 feet of each test location with uninterrupted flow at a minimum pressure of 35 psi at the test specimen.
3. Uninterrupted power sources with 120-volt, two minimum 20 amp receptacles within 200 feet of the interior of each test location.
4. Free and clear access to observe the interior and exterior of test specimens, including concealed interior wall cavities. Interior finishes should not be installed around the test locations.

2.3 TEST REPORTS

A. Test reports will be provided by the BETA after each mock-up and field functional performance test.

B. Reports will include a description of the test method(s) and protocol used as well as all relevant testing parameters and pass/fail criteria. Any deviations from the referenced published testing standards or project documents shall be clearly identified and justification provided by the BETA.

C. Reports will identify specific testing locations and specimens and include photographs of the test specimens before, during, and after testing.

D. Reports will include testing results, including any relevant descriptions and photographs of testing failures. Any diagnostic tests performed in response to failures should also be documented in test reports.

PART 3 - EXECUTION

3.1 MOCK-UP TESTS

A. Mock-ups should be constructed, tested, and accepted prior to commencement of installation of building enclosure systems, assemblies, and components. Refer to project-specific mock-up requirements in Project specification **014339 INTEGRATED EXTERIOR MOCKUPS** and architectural drawings provided by the Architect/Engineer (A/E) detailing mock-up sizes and materials. Mock-ups are anticipated to be an on-site, in-situ mock-up. Components and conditions for inclusion in the mock-up include mortar, accessories, structural backup, wall flashings, windows, curtainwall, and precast as required to show complete wall system. Testing is performed on the installed fenestration systems, air barrier, and any terminations or penetrations through primary air and moisture control components, such as cladding girt fasteners and anchors.

B. Refer to project specifications for mock-up submittal/shop drawing requirements including requirements for project-specific transition details indicating how fenestration systems, air barrier, and claddings interface with adjacent systems.

C. Mockup testing to be performed in one round in the following order at locations directed by Architect.

1. Nozzle Water Penetration Test

   a. Test according to AAMA 501.2-15 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
   b. Test two (2) locations of mockup window systems with no evidence of water penetration.

2. Static Quantitative Air Infiltration Test

   a. Test according to ASTM E783-02(2018) - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

      1) Test two (2) locations of mock-up window systems at 1.5 times the performance rating of the lab tested fenestration product, but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of **6.24** lbf/sq. ft.

   b. Test methods described in ASTM E1186-22 - Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems may be utilized as further diagnostic testing to assist in identifying and prioritizing leak sources.

3. Static Uniform Water Penetration Test

   a. Test according to ASTM E1105-15 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference, Procedure A.

      1) Field testing conducted at two-thirds of the laboratory water penetration resistance performance criteria of the installed fenestration system, but not less than 6.24 lbf/sq. ft.
      2) Test specimens must include perimeter transitions and interfaces with adjacent construction with no evidence of water penetration.

D. The mock-up test performance criteria of “no evidence of water penetration” is defined as follows:

1. Water is contained and drained to the exterior
2. There is no wetting of interior surfaces visible to the building occupants
3. There is no wetting, staining, or other damage or potential damage to completed building equipment, materials, or finishes

E. The coordination and completion of the mock-up construction is the responsibility of the Construction Manager. The CM shall permit observations of the mock-up by the Building Enclosure Commissioning Agent (BECxA) and any member of the Building Enclosure Commissioning Team throughout construction and testing as required.

F. The CM shall notify the BECxA/BETA at least two weeks in advance of desired testing date.

G. In the event of excessive air or observed water leakage through the test sample either during pre-testing or final testing; additional diagnostic and isolation testing should be conducted to determine the cause of failure.

H. Following failed mock-up testing, CM to provide a plan of repairs to be performed to the BECT for review. A/E shall approve plan of repairs prior to implementation and retesting. All repairs performed to facilitate successful testing must be approved by the A/E and performed comprehensively throughout project.

I. Retesting shall be conducted by the BETA. All costs associated with the repair and retesting shall be the responsibility of the contractor, including costs related to performance, observation, and documentation of retesting and additional testing by the BETA and BECxA.

3.2 FIELD TEST REQUIREMENTS

A. Field tests will focus on interfaces and transitions of building enclosure systems, materials, and assemblies. Testing shall be performed prior to the installation of interior insulation, gypsum wall board, interior supplemental sealant joints, and finishes. Specific test locations/specimens will be further developed and identified in the Building Enclosure Commissioning Plan. Specific test locations and conditions will be selected by the A/E and BECxA to include a representative sample of the project. Construction phase field functional performance testing to be performed with general locations/conditions identified as follows:

1. Nozzle Water Penetration Test

   a. Test according to AAMA 501.2-15 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

      1) Test three (3) locations of glazed aluminum curtain walls prior to ten percent (10%), thirty-five percent (35%), and seventy percent (70%) completion of the curtain wall system completion with no evidence of water penetration.
      2) Test three (3) locations of manufactured roof expansion joints with no evidence of water penetration.
      3) Test three (3) locations of preformed joint sealants with no evidence of water penetration.
      4) Test three (3) locations of exterior expansion joint cover assemblies with no evidence of water penetration.

2. Static Quantitative Air Infiltration Test

   a. Test according to ASTM E783-02(2018) - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

      1) Test three (3) locations of glazed aluminum curtain walls prior to ten percent (10%), thirty-five percent (35%), and seventy percent (70%) completion of the curtain wall system completion.
      2) Test to an allowable air leakage rate of 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (75 Pa) per Section 084413 2.1 I.4 and **3.8** C.2.

3. Static Water Penetration Test

a. Test according to ASTM E1105-15 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference, Procedure A. Test specimens must include perimeter transitions and interfaces with adjacent construction.

1) Test three (3) locations of glazed aluminum curtain walls prior to ten percent (10%), thirty-five percent (35%), and seventy percent (70%) completion of the curtain wall system completion.
2) Field testing conducted at 10 lb/sq. ft., two-thirds of the 15 lb/sq. ft. laboratory water penetration resistance performance criteria of the installed curtain wall system per Section 084413 2.1 F.1 and **3.8** C.3 with no evidence of water penetration.

B. Field functional performance testing shall be conducted to project performance requirements as set forth in the Construction Documents and below:

Performance Test	Test Specimen	Performance Criteria
AAMA 501.2 Water Nozzle Penetration	Glazed aluminum curtain walls, manufactured roof expansion joints, preformed joint sealants, exterior expansion joint covers	No evidence of water penetration
ASTM E783 Air infiltration	Glazed aluminum curtain walls	< 0.09 cfm/sf at 6.24 psf
ASTM E1105 Uniform Static Water Penetration	Glazed aluminum curtain walls	No evidence of water penetration at 10 psf

C. The field test performance criteria of “no evidence of water penetration” is defined as follows:

1. Water is contained and drained to the exterior
2. There is no wetting of interior surfaces visible to the building occupants
3. There is no wetting, staining, or other damage or potential damage to completed building equipment, materials, or finishes

3.3 TEST FAILURES

A. All failed testing areas demonstrating deficient conditions or performance are to be repaired and retested at CM’s expense. Retesting shall be conducted by the BETA. All costs associated with the repair and retesting including all access, equipment, labor, and materials, as well as costs incurred by the BETA and BECxA site visits shall be the responsibility of the contractor.

B. In addition to re-testing, failed test will result in testing of at least one (1) additional specimen at a location selected by the BECxA at the cost of the contractor. Testing will be concluded only when satisfactory results are achieved. All failed test specimens shall be repaired and retested until passing results are achieved.

C. Efforts will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. BECxA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so directly by the Owner.

D. Where testing indicates that performance requirements are not met, the contractor shall provide a repair plan for review by the BECT. Once the plan of repairs is agreed upon, Subcontractor corrects deficiency and provides written response and/or documentation on the MIL that the deficiency has been addressed and verifies that material or assembly is ready to be retested. CM informs BECT of retesting schedule and reschedules retesting with BECxA and BETA.

Testing and resolution process is repeated until satisfactory performance is achieved. CM shall maintain free and clear access to the re-test and additional test areas, including exclusion and removal of interior finishes, until satisfactory performance is achieved.

END OF SECTION 019117

SECTION 014339 – INTEGRATED EXTERIOR MOCKUPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Integrated exterior mockups.

B. Related Requirements:

1. Section 019115 "Building Enclosure Commissioning" and Section 019117 “Building Enclosure Functional Performance Testing” for testing building enclosure systems and assemblies as part of the exterior enclosure commissioning process.

1.2 DEFINITIONS

A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Construction Manager, Architect, testing and inspecting agency representative, manufacturer’s representatives, fabricators, installers of major systems and other interested parties whose Work is included in integrated exterior mockups.
2. Review locations and extent of mockups.
3. Review testing procedures to be performed on mockups.
4. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and testing and maintain schedule for the Work.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior mockups.

1. Include plans, elevations, sections, and support details.
2. Indicate manufacturer and model number of individual components, subassemblies, and assemblies.
3. Include site location drawing.
4. Revise and resubmit Shop Drawings to reflect approved modifications in details and component interfaces resulting from changes made during testing procedures.

B. Delegated Design Submittal: For temporary structural supports for mockups not attached to building structure, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Preconstruction Test Reports: For integrated exterior mockups.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.

B. Build mockups to do the following:

1. Verify selections made under Sample submittals.
2. Demonstrate aesthetic effects.
3. Demonstrate the qualities of products and workmanship.
4. Demonstrate acceptable coordination between components and systems.
5. Perform preconstruction testing, such as window air- and water-leakage testing.

C. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.

1. Size: As indicated on approved Mockup Shop Drawings, and as follows:

    a. Width: Mockup shall be one structural bay in width (approximately 30 feet)
    b. Height: Minimum truncated height required to include all elements of full-height wall (approximately 16 feet).

2. Build mockups in location indicated or, if not indicated, as directed by Architect or Construction Manager.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

D. Notifications:

1. Notify Architect and Construction Manager seven days in advance of the dates and times when mockups will be constructed.
2. Notify Architect and Construction Manager 14 days in advance of the dates and times when mockups will be tested.
3. Allow seven days for initial review and each re-review of each mockup.

E. Approval: Obtain Architect's and Construction Manager's approval of mockups before starting fabrication or construction of corresponding Work.

1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 COORDINATION

A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design support structure for free-standing mockups.

B. Structural Performance:

1. Wind Loads: As indicated on Drawings.

C. Mockup Testing Performance Requirements: Perform tests using design pressures and performance criteria indicated for assemblies and products that are specified in other Sections and incorporated into integrated exterior mockups.

2.2 INTEGRATED EXTERIOR MOCKUPS

A. Construct integrated exterior mockups according to approved mockup Shop Drawings. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

B. Design and construct foundation and superstructure to support free-standing integrated exterior mockups.

C. Build integrated exterior mockups using installers and construction methods that will be used in completed construction.

D. Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.

E. The Work of integrated exterior mockups includes, but is not limited to, the following:

1. Cast-In-Place Concrete Exterior Backup Wall System.
2. Masonry veneer.
3. Mortar joints, color and tooling.
4. Control joints.
5. Stone cladding.
6. Typical Exterior Backup Wall System including cold-formed metal framing and sheathing.
7. Composite metal hybrid (CMH) continuous insulation sub-framing support systems.
8. Self-adhering sheet waterproofing.
9. Air barriers.
10. Thermal insulation.
11. Cavity drainage: Through-wall flashing and weeps.
12. Flashing and sheet metal trim.
13. Joint sealants.
14. Metal composite material wall panels.
15. Parapet fascia, trim.
16. Wood veneer laminate wall panels.
17. Aluminum-framed entrances and storefront.
18. Glazed curtain walls.
19. Glazing.

F. Photographic Documentation: Document construction of integrated exterior mockups with photographs. Provide photographs showing details of interface of different materials and assemblies.

1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

G. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.

H. Retain approved mockups constructed in place. Incorporate fully into the Work.

PART 3 - EXECUTION

3.1 TESTING OF INTEGRATED EXTERIOR MOCKUPS

A. Integrated Exterior Mockup Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested Work complies with or deviates from requirements.

B. Integrated Exterior Mockup Testing Services: Perform the following tests in the following order:

1. Water-Spray Test: Before installation of interior finishes has begun, test areas designated by Architect in accordance with AAMA 501.2 for evidence of water penetration.

a. Perform a minimum of two tests in areas as directed by Architect.

2. Air Leakage: Test in accordance with ASTM E783 at 1.5 times the rate specified in "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements"

Article, but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

a. Perform a minimum of two tests in areas as directed by Architect.

3. Water Penetration: Test in accordance with ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and verify no evidence of water penetration.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections, and also to observe testing for systems and assemblies required in other Specification Sections.

D. Integrated exterior mockup will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 014339

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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 administrative and procedural requirements for the following:

1. Recycling nonhazardous construction waste.
2. Disposing of nonhazardous construction waste.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.

1.3 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Construction Waste Management Tracking Worksheet at the end of this section.

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: Submit documentation to USGBC, 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. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the Project's LEED certification application. Document correspondence with USGBC as informational submittals.

H. Qualification Data: For waste management coordinator.

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.

1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
2. Waste management coordinator may also serve as LEED coordinator.

B. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "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 each contractor and 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.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in 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 demolition and construction waste generated by the Work. 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. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
2. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
3. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling 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 transportation and tipping fees by donating materials.
7. Savings in transportation 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)

2.1 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total nonhazardous 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.

PART 3 - EXECUTION

3.1 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 015000 "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 and recycled.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. 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.

C. 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 Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 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.

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.

D. Paint: Seal containers and store by type.

3.4 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, 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.

3.5 ATTACHMENTS

A. Construction Waste Management Tracking Worksheet.

END OF SECTION 017419

Calculator

017419A Construction Waste Management Tracking

Material Description	Material Type	Material Stream	Total Waste (cubic yards)	Commingled Waste: Average Percentage of ADC Produced by the Sorting Facility (%)	Diverted Waste (cubic yards)	Percent Diverted (%)	Waste to Landfill (cubic yards)
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
						0.00%	0.00
Total construction waste (cubic yards)							0.00
Total diverted construction waste (cubic yards)							0.00
For D+C projects	Total number of material streams						0
For ND projects	Total diverted asphalt, brick, and concrete (ABC) waste (cubic yards)						0.00

https://www.usgbc.org/resources/leed-v41-construction-and-demolition-waste-management-calculator

SECTION 018113.20 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4.1 BD+C: NEW CONSTRUCTION AND MAJOR RENOVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements and procedures for compliance with USGBC's LEED prerequisites and credits needed for Project to obtain LEED Silver certification based on USGBC's "LEED v4.1 for Building Design and Construction" (hereafter, LEED v4.1 BD+C).

1. Specific requirements for LEED are also included in other Sections.
2. 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.
3. A copy of LEED Project checklist is attached at end of this Section for information only.

    a. Some LEED prerequisites and credits needed to obtain indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.2 DEFINITIONS

A. ANSI/BIFMA e3 Furniture Sustainability Standard: Standard addressing environmental and social impacts throughout the furniture supply chain.

B. BUG Rating Method: The BUG rating of a fixture determines how much light trespass is produced by considering backlight (B), uplight (U), and glare (G).

C. 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. Certificates to include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

D. Cradle to Cradle: Product certification assessing material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness.

E. Declare: A product transparency disclosure that identifies material source, composition, and end-of-life procedures.

F. Environmental Product Declaration (EPD): A transparency reporting tool communicating what a product is made of and the environmental impact.

G. Health Product Declaration (HPD): Disclosure of products contents and associated health information.

H. Recycled Content: The recycled content value of a material assembly to 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. "Postconsumer" 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. "Preconsumer" material is defined as material diverted from the waste stream during the manufacturing process. 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) is excluded.
3. ded.

I. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) 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) contributes to the regional value.

J. WaterSense Label: The WaterSense label from the EPA specifies water efficiency and performance.

K. Whole-Building Life-Cycle Assessment: The Life Cycle Assessment (LCA) is a methodology that evaluates the carbon and other environmental impacts of building materials over the projected lifespan of the building.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Review sustainability goals, municipal and state sustainability requirements, LEED objectives, and action plans for meeting requirements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect about USGBC's LEED prerequisites and credits that are Contractor's responsibility, that depend on product selection or product qualities, or that depend on Contractor's procedures until USGBC has made its determination on Project's LEED certification application.

1.5 ACTION SUBMITTALS

A. General: Submit sustainable design submittals required by other Sections.

B. Sustainable design submittals are in addition to other submittals.

1. If submitted item is identical to that submitted to comply with other requirements, include additional copy with other submittal as a record of compliance with indicated LEED requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."

C. Sustainable Design Documentation Submittals:

1. Plumbing submittal packages.
2. Mechanical submittal packages.
3. EPDs complying with LEED requirements.

4. Documentation for products that comply with LEED requirements for multi-attribute optimization.
5. Sustainability reports for products that comply with LEED requirements for sourcing of raw materials.
6. Material ingredient reports for products that comply with LEED requirements for material ingredient reporting.
7. Documentation for products that comply with LEED requirements for material ingredient optimization.
8. Documentation complying with Section 017419 "Construction Waste Management and Disposal."
9. Product data for adhesives and sealants used inside the weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
10. Product data for paints and coatings used inside the weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
11. Laboratory test reports for flooring, indicating compliance with requirements for low-emitting materials.
12. Laboratory test reports for wall materials, indicating compliance with requirements for low-emitting materials.
13. Laboratory test reports for ceilings, indicating compliance with requirements for low-emitting materials.
14. Laboratory test reports for insulation, indicating compliance with requirements for low-emitting materials.
15. Laboratory test reports for furniture, indicating compliance with requirements for low-emitting materials.
16. Laboratory test reports for products containing composite wood or agrifiber products or wood glues, indicating compliance with requirements for low-emitting materials.
17. Construction Indoor Air Quality (IAQ) Management:

    a. Construction IAQ 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 construction period, along with a brief description of SMACNA approach employed, documenting implementation of IAQ management measures, including protection of ducts and on-site stored or installed absorptive materials.

18. IAQ Assessment:

    a. Signed statement describing the building air flush-out procedures, including 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 occupancy.
    c. Report from testing and inspecting agency indicating results of IAQ testing and documentation showing compliance with IAQ testing procedures and requirements.

1.6 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. Plumbing.
2. Mechanical.
3. Electrical.
4. Specialty items, such as elevators and equipment.

C. Sustainable Design Action Plans: Provide preliminary submittals within 30 days of the Notice to Proceed, indicating how the following requirements will be met:

1. List of proposed products with EPDs.
2. List of proposed products complying with requirements for multi-attribute optimization.
3. List of proposed products complying with requirements for sourcing of raw materials.
4. List of proposed products complying with requirements for material ingredient reporting.
5. List of proposed products complying with requirements for material ingredient optimization.
6. Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
7. Construction IAQ management plan.
8. IAQ assessment plan.

D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.7 QUALITY ASSURANCE

A. LEED Coordinator: Engage an experienced LEED AP to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide products and procedures necessary to obtain LEED credits indicated as Contractor's responsibility. Although other Sections may specify some requirements that contribute to these LEED credits, Contractor provides additional materials and procedures necessary to obtain LEED credits indicated.

B. At least 20 different products from at least five different manufacturers have EPDs that comply with LEED requirements. Product-specific Type III EPDs are valued as one and one-half of a product.

C. At least 10 percent, by cost, of permanently installed products for Project comply with LEED requirements for multi-attribute optimization.

D. At least 20 different products from at least five different manufacturers have publically released reports that comply with LEED requirements for sourcing of raw materials.

E. At least 20 different products from at least five different manufacturers comply with LEED requirements for material ingredient reporting.

F. At least 10 percent, by cost, of permanently installed products for Project comply with LEED requirements for material ingredient optimization.

G. Recycled Content: Building materials have recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content for Project constitutes a minimum of 15 percent of cost of materials used for Project.

1. Cost of postconsumer recycled content plus one-half of preconsumer recycled content of an item to be determined by dividing weight of postconsumer recycled content plus one-half of preconsumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include plumbing, mechanical and electrical components, and specialty items, such as elevators and equipment, in the calculation.

2.2 LOW-EMITTING MATERIALS

A. Paints and Coatings: For field applications that are inside the weatherproofing system, 75 percent of paints and coatings meet the VOC emissions evaluation and 100 percent meet the VOC content evaluations.

B. Adhesives and Sealants: For field applications that are inside the weatherproofing system, 75 percent of adhesives and sealants meet the VOC emissions evaluation and 100 percent meet the VOC content evaluations.

C. Flooring: A minimum of 90 percent of flooring products meet the VOC emissions evaluation or inherently non-emitting sources criteria or salvaged and reused materials criteria. Subflooring is excluded.

D. Walls: A minimum of 75 percent of wall panel products meet the VOC emissions evaluation or inherently non-emitting sources criteria or salvaged and reused materials criteria. Wall panel products include wall paneling, wall coverings, wall tile, surface wall structures, cubicle/curtain/partition walls, trim, doors, frames, windows, and window treatments. Removable/interchangeable fabric panels, built-in cabinetry, and vertical structural elements are excluded.

E. Ceilings: A minimum of 90 percent of ceilings meet the VOC emissions evaluation or inherently non-emitting sources criteria or salvaged and reused materials criteria. Ceiling products include ceiling panels, ceiling tile, surface ceiling structures, suspended systems, and glazed skylights. Overhead structural elements are excluded.

F. Insulation: A minimum of 75 percent of insulation products meet the VOC emissions evaluation. Insulation products include all thermal and acoustic boards, batts, rolls, blankets, sound attenuation fire blankets, and foamed-in-place, loose-fill, blown, and sprayed insulation. HVAC duct and plumbing piping insulation are excluded.

G. Furniture: A minimum of 75 percent of furniture meets the furniture emissions evaluation or inherently non-emitting sources or salvaged and reused materials criteria. All standalone furniture is included.

H. Composite Wood: A minimum of 75 percent of all composite wood meet the formaldehyde emissions evaluation or salvaged and reused materials criteria. Composite wood materials include particleboard, MDF, hardwood veneer plywood, and structural composite wood.

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

A. Smoking is not permitted on the project site and all tobacco products are prohibited on University property.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Comply with Section 017419 "Construction Waste Management and Disposal."

3.3 CONSTRUCTION INDOOR AIR QUALITY (IAQ) MANAGEMENT

A. 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 015000 "Temporary Facilities and Controls," install MERV 8 filter media in accordance with ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
2. Replace air filters immediately prior to occupancy with new filters specified in Section 234100 "Particulate Air Filtration."

3.4 INDOOR AIR QUALITY (IAQ) ASSESSMENT

A. Flush-Out:

1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14,000 cu. ft. (4 300 000 L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.
2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. (1 070 000 L) of outdoor air per sq. ft. (sq. m) of floor area to the space. Once a space is occupied, it is ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside-air rate prerequisite, whichever is greater. During each day of the flush-out period, ventilation begins a minimum of three hours prior to occupancy and continues during occupancy. These conditions are maintained until a total of 14,000 cu. ft./sq. ft. (4 300 000 L/sq. m) of outside air has been delivered to the space.

B. Air-Quality Testing: Owner will engage testing agency to perform the following:

1. Conduct baseline IAQ 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 USGBC's "LEED v4.1 Reference Guide for Building Design and Construction."

2. Demonstrate that contaminant maximum concentrations listed below are not exceeded:

    a. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
    b. Particulates (PM10): 50 mcg/cu. m.
    c. Particulates (PM2.5): 12 mcg/cu. m.
    d. Ozone: 0.07 ppm, in accordance with ASTM D5149.
    e. Formaldehyde: 20 mcg/cu. m.
    f. Acetaldehyde: 140 mcg/cu. m.
    g. Benzene: 3 mcg/cu. m.
    h. Hexane: 7000 mcg/cu. m.
    i. Naphthalene: 9 mcg/cu. m.
    j. Phenol: 200 mcg/cu. m.
    k. Styrene: 900 mcg/cu. m.
    l. Tetrachloroethylene: 35 mcg/cu. m.
    m. Toluene: 300 mcg/cu. m.
    n. Vinyl Acetate: 200 mcg/cu. m.
    o. Dichlorobenzene: 800 mcg/cu. m.
    p. Xylenes - Total: 700 mcg/cu. m.

3. For each sampling point where the maximum concentration limits are exceeded, take corrective action until requirements have been met.
4. Air-sample testing to be conducted as follows:

    a. All measurements to 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-airflow rate for the occupied mode throughout the duration of the air testing.
    b. Building to 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.
    c. 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 to not be less than one per 5000 sq. ft. (465 sq. m). For large open spaces, one sampling point per 50,000 sq. ft. (4654 sq. m) may be used.
    d. Air samples to be collected between 3 and 6 ft. (0.9 and 1.8 m) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 018113.20

LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Project Name: UK Cancer Center
Date: 4-5-2024

Y	?	N			
1			Credit	Integrative Process	1

6	3	7	**Location and Transportation**		16
		16	Credit	LEED for Neighborhood Development Location	16
1			Credit	Sensitive Land Protection	1
		2	Credit	High Priority Site	2
2		3	Credit	Surrounding Density and Diverse Uses	5
3	2		Credit	Access to Quality Transit	5
		1	Credit	Bicycle Facilities	1
		1	Credit	Reduced Parking Footprint	1
	1		Credit	Green Vehicles (v4) / Electric Vehicles (v4.1)	1

6	1	3	**Sustainable Sites**		10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
		2	Credit	Site Development - Protect or Restore Habitat	2
		1	Credit	Open Space	1
2	1		Credit	Rainwater Management	3
2			Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1

3	4	4	**Water Efficiency**		11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
		2	Credit	Outdoor Water Use Reduction	2
2	4		Credit	Indoor Water Use Reduction	6
		2	Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1

16	5	12	**Energy and Atmosphere**		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
5	1		Credit	Enhanced Commissioning	6
9	2	7	Credit	Optimize Energy Performance	18
1			Credit	Advanced Energy Metering	1
		2	Credit	Demand Response	2
		3	Credit	Renewable Energy Production	3
1			Credit	Enhanced Refrigerant Management	1
	2		Credit	Green Power and Carbon Offsets	2

7	4	2	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
1	2	2	Credit	Building Life-Cycle Impact Reduction	5
1	1		Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
1	1		Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
2			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2

8	8	0	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
1	1		Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
	2		Credit	Indoor Air Quality Assessment	2
1			Credit	Thermal Comfort	1
1	1		Credit	Interior Lighting	2
	3		Credit	Daylight	3
	1		Credit	Quality Views	1
1			Credit	Acoustic Performance	1

6	0	0	**Innovation**		6
5			Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

2	1	1	**Regional Priority**		4
	1		Credit	Regional Priority: Optimize Energy Performance (Threshold 10pts)	1
		1	Credit	Regional Priority: Outdoor water use reduction (Threshold 1pt)	1
1			Credit	Regional Priority: Rainwater Management (Threshold 1pt)	1
1			Credit	Regional Priority: Indoor Water Use Reduction (Threshold 1pt)	1

55	26	29	**TOTALS**	Possible Points:	**110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

PRODUCT DATA REPORTING FORM for LEED v4 & v4.1 Projects

THIS FORM IS REQUIRED TO BE SUBMITTED *WITH Product Data Submittals*

You must include backup documentation such as *SPECIFIC* Product Data Sheets, 3rd party certification, Cut Sheets, Product Specific Letter from Manufacturer, etc. (Not marketing material)

LEED PROJECT NAME: UK Healthcare Cancer Treatment Center & Advanced Ambulatory Center

SUBCONTRACTOR: _____

Specification Section: _____

HGA + CHAMPLIN ARCHITECTURE

	Project Product Data			*Materials and Resources LEED Credits*								*Low-Emitting Materials LEED Credits*				
				Environmental Product Declarations		**Sourcing of Raw Materials**				**Material Ingedients**		**Some Qualifying VOC Standards (More in Note 10):** CDPH Standard Method v1.1 or v1.2; FloorScore: Hard Surfaces & Adhesives; Green Label Plus: Carpet, Adhesive, Cushion; UL Greengaurd Gold: When Meeting CDPH Std				
	Manufacturer	**Product Name**	**Product Costs (only exclude labor) ($)**	**Product Specific (PS) or Industry Wide (IW) Env. Product Declaration (EPD)?**	**EPD Optimization (GWP reduction)**	**FSC Certified Wood Products? (%)**	**Post-Consumer Recycled Content (%)**	**Pre-Consumer Recycled Content (%)**	**Extended Producer Responsibility Takeback? (Yes/No)**	**Material Ingredient Reporting (to 1000 ppm) - Select Compliance Option**	**Extracted, Manufactured, & Purchased within[2] 100 miles? (Yes/No)**	**CDPH Emissions[10] testing compliant? (Yes/No)**	**VOC Content[11] (g/L)**	**Wet-Applied Products Volume Used (L)**	**Wood Products are ULEF or NAUF[12]? (Yes/No)**	**Wood Products are CARB exempt? (Yes/No)**
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

I, _____ a duly authorized representative of _____ hereby certify that the material information submitted here is an accurate representation of the material to be provided under our contract.

EMAIL FOR AUTHORIZED REPRESENTATIVE: _____ **Direct Phone:** _____

SIGNATURE OF AUTHORIZED REPRESENTATIVE: _____ **Date:** _____

NOTES / DEFINITIONS:

1. Furnish Costs include all expenses to deliver the material to the project site, including taxes, transport, fabrication and profit. Do not include site labor or installation.
2. Within 100 miles distance is defined as travel by air to the project site, not travel distance by road. http://www.distancefromto.net/
3. Environmental Product Declarations which conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope. http://productguide.ulenvironment.com/QuickSearch.aspx
4. The end use product has a published, complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration open Standard.
5. Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. (e.g. Closed Loop or Take Back Program)
7. Wood products must be certified by the Forest Stewardship Council (FSC) and must be provide proof of vendor FSC Chain-of-Custody with this Product Data Submittal. http://info.fsc.org/certificate.php
8. Post-Consumer Recycled Content: Sourced from recovered Consumer Waste and used as a raw material (e.g. plastic bottles, newspaper, etc).
9. Pre-Consumer Recycled Content: Recovered Industrial Materials diverted from municipal solid waste for use in a different mfg. process, prior to use by a consumer. Note: "home scrap" from the original mfg. process that are reused / reprocessed do not qualify.
10. TVOC Emissions for Building products must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.1–2010
11. All paints and coatings wet-applied on site must meet applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective June 3, 2011. All adhesives and sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, July 1, 2005, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168.
12. Composite Wood Evaluation as defined by the California Air Resources Board (CARB), Airborne Toxic Measure to Reduce Formaldehyde Emissions from Composite Wood Products Regulation, must be documented to have low formaldehyde emissions that meet the CARB ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde (NAUF) resins.

SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Engineering Survey: Submit engineering survey of condition of building.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations.

E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video and templates.

1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.3 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least two hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. All labor, materials, equipment, special tools and services to complete cast-in-place concrete work required for the Project, as herein specified, and as indicated on the Drawings.

B. Related Sections:

1. Section 041500 – Masonry Reinforcement and Accessories.
2. Section 042000 – Unit Masonry
3. Section 051200 – Structural Steel.
4. Section 053000 – Metal Decking.
5. Section 071000 – Waterproofing.
6. Section 312000 – Earthwork.
7. Section 315000 – Temporary Retention System, Bracing, and Underpinning.
8. Section 316320 – Drilled Piers.
9. Divisions 21 through 26 – Pads, inserts, sleeves and embedments for mechanical and electrical items specified therein.

1.3 REFERENCES

A. A copy of each reference shall be kept in the field office for the duration of the project. The reference standards shall govern the work except as modified herein.

B. American Concrete Institute (ACI) 301-16 Specifications for Structural Concrete is hereby incorporated as part of this Section. Supplemental requirements and modifications listed herein take precedence over the requirements of ACI 301. All ACI 301 items, unless modified by the Contract Documents are incorporated as written. When part of an item is modified or voided, the unaltered provisions of the item shall apply as written.

C. ACI 305.1-14 Specification for Hot Weather Concreting.

D. ACI 306.1-90 Standard Specification for Cold Weather Concreting.

E. The ACI MNL-15(16) Field Reference Manual.

F. Other ACI references as noted in this Section.

G. American Association of State Highway and Transportation Officials (AASHTO) Specifications as noted in this Section.

H. ASTM International (ASTM) Specifications as noted in this Section.

I. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice, 29th Edition.

J. National Ready Mixed Concrete Association (NRMCA) Quality Control Manual.

1.4 SUBMITTALS

A. General.

1. Shop drawings shall be produced by the Contractor and submitted to the Architect/Engineer for review. The Architect/Engineer will endeavor to complete review of a shop drawing submittal within 14 days of receipt of the submittal. Fabrication of material prior to the receipt of corresponding approved shop drawings shall be at the Contractor's risk.
2. The Contractor is responsible to furnish field-verify information, coordinate material requirements, and review shop drawings prior to submittal of shop drawings to the Architect/Engineer. Receipt of shop drawings by Architect/Engineer will be an assumption by Architect/Engineer that this has been done.
3. Notations by the Architect/Engineer made on the shop drawings do not authorize additional compensation for the Contractor.
4. The Contract Documents (Drawings and Specifications) govern all concrete work. Errors on shop drawings or discrepancies between shop drawings and Contract Documents shall be governed by the Contract Documents. Even if shop drawings contain errors after review by the Architect/Engineer, no additional compensation shall be due the Contractor to correct work to what is shown on the Contract Documents.
5. Architectural and mechanical drawings supplement the structural drawings. Requirements for concrete work may be shown on architectural and mechanical drawings.
6. The Architect's and Engineer’s review of details and construction operations shall not relieve the Contractor of responsibility to successfully complete the work in accordance with these Specifications and within the Contract time.
7. Shop drawings may be received and returned electronically. If paper copies are submitted no more than two copies will be returned to the Contractor or Construction Manager.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certifications: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Laboratory Test Reports: For curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

C. Submit mix designs and test results conforming to the requirements of Section 4 of ACI 301. Submit request for approval to use admixtures, if any. A complete mix design submittal must be furnished at least three weeks prior to the planned use of that mix. The Contractor is cautioned to undertake mix design preparation and submittal procedures immediately after authorization to proceed with the Project.

1. The submitted mix designs shall address weather conditions that are expected to occur during the concrete construction phase. Concrete mixes shall not only be designed for average temperature and humidity conditions, but also for adverse conditions (hot and cold weather), as applicable to this project.

D. Submit letter stating that concrete subcontractors and suppliers are familiar with the reference standards.

E. Submit a Quality Control Plan in accordance with Section 1 of ACI 301.

F. Submit reinforcing steel shop drawings in accordance with Section 3 of ACI 301.

G. Submit formwork shop drawings for record only. For multistory construction submit record calculations of shoring and reshoring loads sealed by a professional engineer licensed in the state where the Project is located. Design and inspection of formwork for structural adequacy is the Contractor's responsibility. Prior to submittal, formwork shop drawings shall be reviewed by the Contractor's registered professional engineer.

H. For exposed-to-view concrete work submit formwork shop drawings for architectural review of formwork factors affecting appearance of the completed Work, including types of forms, ties, finishes, and joint types and locations. Review is for general architectural applications and features only.

1. Where the finish is to match a reference sample, produce a mockup that matches the reference sample in a location approved by the Architect. Obtain acceptance of the mockup before proceeding with that finish in the locations designated on the Drawings.

I. Submit procedures and records required in hot and cold weather concreting work.

J. Submit insert certifications and installation instructions requested herein for ledge angle inserts (See ACI 301, Section 5.2.1.10).

K. Submit documentation that the epoxy coating applicator is certified under the Concrete Reinforcing Steel Institute’s Fusion-Bonded Epoxy Coating Applicator Plant Certification Program.

L. Submit the following certifications:

1. All coating, floor covering and surface treatment manufacturer's approvals (in writing) of concrete curing compounds that are not removed prior to the product’s installation.
2. Subsequent treatment manufacturers' approvals (in writing) of form release agent.

M. Submit the following product samples for review:

1. Samples of form(s) to be used for exposed-to-view concrete.

N. The following submittals shall be provided in accordance with ACI 301 and Division 01 - General Requirements.

1. Contractor’s proposed Testing Agency.
2. Field and Laboratory tests that are the Contractor’s responsibility.
3. Data and test documentation on proposed materials including but not limited to:
   a. Cement.
   b. Aggregates.
   c. Admixtures.
   d. Reinforcing.
   e. Curing materials.
   f. Related materials for concrete construction specified herein.
   g. Material for repair of surface defects if other than site-mixed portland-cement mortar.
4. Construction joints not shown on the drawings.
5. Method of developing bond at joints (except slabs on grade).
6. Method of adding admixtures.
7. Procedure for adding water to ready-mixed concrete at site, including method of measuring water.
8. Method(s) for preserving moisture in the concrete.
9. Ready-mixed concrete delivery tickets.
10. Thermal control plan for all mass concrete placements.

O. Submit NRMCA Certificate of Conformance for concrete production facilities.

P. Submit documentation of all flatwork finishers and flatwork supervisors' certifications.

1.5 QUALITY ASSURANCE

A. Regulatory requirements:

1. Comply with applicable laws, ordinances, and the Kentucky Building Code (KBC).
2. Comply with the referenced ACI publications, as modified and supplemented in this Section.

B. Tests and inspections:

1. The Owner will employ a Geotechnical Engineer to inspect and approve foundation bearings and backfill compaction. Do not place concrete until subgrade approvals have been obtained.
2. The Owner will employ a testing and inspection agency to provide the services specified in Section 1.6.3 of ACI 301, including supplemental requirements defined in Article 1.8 of this Specification.
3. The Contractor shall select an independent testing agency, subject to the Architect/Engineer's approval, to perform all testing required by the Contractor for qualification of proposed materials and the establishment of mix designs, for the Contractor's use in determining concrete strengths for early form removal, and for all other testing services needed or required by the Contractor.

C. Flatwork finishers certification:

1. All flatwork finishers shall be ACI Concrete Flatwork Technician certified.
2. The on-site flatwork supervisor shall be ACI Concrete Flatwork Finisher and Technician certified.

D. Ready Mixed Plant Certification:

1. All ready-mixed concrete production facilities shall have a current Certification of Ready Mixed Concrete Production Facilities from the NRMCA, or equivalent.

E. Preconstruction Meeting:

1. A preconstruction meeting shall be arranged by the Contractor to review concrete pre-placement and placement activities, inspection and testing requirements, formed and unformed concrete finishes, hot and cold weather concreting procedures, form removal, critical tolerances, and acceptance procedures for architectural concrete.
2. The meeting shall be held three weeks or more before the first non-foundation concrete placement.
3. Ready-mix supplier, Contractor, concrete finishers, Construction Manager, Owner's concrete testing agency, and Architect/Engineer shall attend.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver reinforcement to the project site bundled, tagged and marked. Use durable tags indicating bar size, lengths, etc., and other information corresponding to markings shown on placing drawings.

B. All reinforcement at the site shall be stored off the ground and protected from damage, accumulation of dirt and excessive rust.

C. Comply with ASTM D3963 'Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars' and the Appendix of ASTM A775 'Standard Specification for Epoxy-Coated Steel Reinforcing Bars' for jobsite handling of epoxy-coated rebar.

D. All formwork at the site shall be stored in a clean, dry location off the ground, covered and protected from damage and accumulation of dirt, etc.

1.7 SUBSTITUTIONS

A. Requests for product substitutions must be submitted for review and approval, with all necessary documentation, a minimum of 10 days before bids are due. Product substitutions will only be permitted if incorporated into the bid documents by addendum.

1.8 SUPPLEMENTAL REQUIREMENTS AND MODIFICATIONS TO ACI 301-16

A. The following statements modify and supplement ACI 301. All unaltered parts of ACI 301 shall apply as written.

B. The Section and paragraph numbers correspond to those in ACI 301. Note that each technical section of ACI 301 includes General requirements, Products, and Execution per the Three-Part Section Format of the Construction Specification Institute.

Section 1 (ACI 301) - General Requirements

1.5.3.1 The Contractor shall submit a quality control plan that addresses the following.

(a) Control and maintenance of project documents.
(b) Subcontractor/supplier services and verification of purchased products and materials.
(c) Concrete production inspection and testing.
(d) Pre-placement inspection including formwork, reinforcing and embedments.
(e) Placement inspection including consolidation, finishing and initial curing of concrete.
(f) Post-placement inspection including monitoring of moist curing and curing temperatures, verification of in-place strength before removal of shoring, and protection of exposed surfaces.

1.6.2.2(c) The Contractor shall arrange for all testing and inspections, giving the Owner's testing agency at least 24 hours advance notice.

1.6.2.2(d)1 The Contractor shall provide curing boxes as required by ASTM C31. Coordinate quantity and location with the Construction Manager and Testing Agency.

1.6.3.1(c) The Owner's testing agency shall report in writing all test results to Architect/Engineer, Contractor, Construction Manager and concrete supplier within three (3) working days after the tests are performed. Report by phone or email the results of early break cylinders to Contractor and Construction Manager. Reports of strength tests shall contain the name of the project, date and time of placement, location of placement, placement method, water added at site, sample location, weather conditions, batch ticket number, batch size, mix identification, specified strength, breaking strength and type of break, specimen diameter and weight, types of admixtures, percentage of entrained air, slump, concrete temperature, and detailed information of storage and curing of specimens before testing.

1.6.3.2(d)1 Unless noted otherwise concrete shall have at least one strength test for each 150 cubic yards, or fraction thereof, placed in any one day, nor less than one test for each 5000 square feet of surface area of slabs or walls, or fraction thereof. Strength tests are not required for backfill concrete.

1.6.3.2(d)2 Determine the slump (ASTM C143) for each batch of concrete that high-range water-reducer (superplasticizer) is added to in the field. Test and report slump both before and after superplasticizer is added.

1.6.3.2(e)1 When 6 by 12 in. cylinders are used make four test specimens for each sample (five required for mixes requiring 56 day strength tests). When 4 by 8 in. cylinders are used make five test specimens for each sample (six required for mixes requiring 56 day strength tests). One specimen shall be a hold specimen, to be tested only if a defective specimen is found.

1.6.3.2(e)2 Age of concrete for acceptance shall be 28 days unless otherwise shown in TABLE 4.2.2.8.b. Concrete mixes with strength specified at 56 days shall have one cylinder tested at 7 days, one at 28 days, and two 6 by 12 in. cylinders or three 4 by 8 in. cylinders at 56 days.

1.6.3.2(f) Air content tests shall be conducted on the first three batches in each placement of all mixes in which air entrainment is specified and until three consecutive batches have air contents within the range specified, at which time every third batch shall be tested. This test frequency shall be maintained until a batch is not within the range specified, at which time testing of each batch will be resumed until three consecutive batches have air contents within the specified range.

1. For pumped concrete the second or third batch in the placement, and periodically throughout the placement but not less than once for each 100 cubic yards, shall have air content checked at both the end of the truck discharge and at the end of the hose.
2. Concrete that does not satisfy air entrainment requirements shall be rejected.

1.6.3.2(g) Testing services provide a basis for acceptance or rejection of concrete furnished by this contract. Therefore, it is necessary that testing for air content and slump not only be done after all adjustments have been made, but before the concrete is discharged.

1.6.3.3(f) The Owner will employ an inspection agency to visually inspect the placement of reinforcing steel. Reference KBC 1704.4. Do not place concrete until all outstanding issues cited in the inspection reports have been corrected. Inspection of reinforcing steel to include, but not limited to:

1. Size, spacing, and quantity of bars.
2. Bar splices.
3. Embedments.
4. Concrete cover.
5. Support and securement.
6. Coatings.

1.6.3.3(g) The Owner will employ an inspection agency to inspect concrete operations including, but not limited to:

1. Use of proper concrete mix.
2. Consolidation.
3. Finish and finishing operations.
4. Curing methods, materials, and procedures.
5. Shoring removal and reshoring operations.
6. Formwork materials.

1.6.4.1(a) Contractor shall be responsible for costs of tests on hardened concrete performed by Owner's testing agency if the tests are required to verify the strength or air content of the concrete because representative concrete cylinder tests or air content tests failed to meet acceptance criteria. Owner will be responsible for costs of tests on hardened concrete performed by Owner's testing agency if the tests are at the Owner's request and representative concrete cylinder and air content tests meet acceptance criteria.

1.6.8.4 Concrete which fails to meet the requirements of this Specification shall be rejected.

1.7.1.6 The Contractor shall bear all costs of correcting rejected work, including the cost of the Architect's and Engineer's additional services thereby made necessary.

1.8.4 Masonry shall not be placed on or supported off of structural floors until the concrete is at least 28 days old and all shoring has been removed.

Section 2 (ACI 301) - Formwork and Formwork Accessories

2.1.2.1(g) Form tie configuration and spacing for all exposed-to-view concrete shall be submitted for review and approval of the Architect.

2.2.1.3 Form release agent shall be a commercial formulation form coating compound that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. The form release agent manufacturer shall certify that the form release agent is chemically and physically compatible with all subsequent treatments of concrete surfaces. Furthermore, the form release agent shall be approved in writing by the manufacturers of all subsequent treatments.

2.2.1.4 Preformed Expansion Joint Filler: Non-impregnated type, closed cell resilient polyethylene foam, 1/2 in. thick unless otherwise noted on the Drawings.

2.2.1.5(a) Waterstops:

1. Bentonite rope joint sealant shall be installed in all vertical and horizontal construction joints in concrete walls below and exposed to grade, including slab/wall construction joints, unless otherwise noted. Secure with manufacturer's adhesive and mechanical fasteners as required for a secure installation. Construction joint shall be clean and dry. Prior approved products: Volclay Waterstop-RX 101T, HYPER STOP DB-2515, QUELLMAX 18x24.
2. Unless otherwise noted provide ribbed type, virgin PVC waterstop meeting Corps of Engineers CRD-C 572 at expansion joints in below grade and exposed to grade walls. Expansion Joint Waterstop shall be type with center bulb, and center bulb shall be 100% within joint. Do not embed center bulb in concrete. Expansion Joint Waterstop to be minimum 9 in. wide, and all butt joints shall be cut in miter box and welded per manufacturer's recommendations. Provide premolded unions, fittings and appropriate adhesive. Thoroughly clean joint, secure waterstop to reinforcing mat with hog rings, and vibrate concrete to eliminate voids.

2.2.1.5(b) Embedded items shall not be made of aluminum.

2.2.2.1 Design and engineering of formwork shall be the responsibility of the Contractor. Design of formwork and preparation of formwork drawings shall be under the

supervision of a licensed design engineer registered in the state where the Project is located. Formwork drawings shall be sealed by the licensed design engineer responsible for the design of the formwork.

2.2.2.3 Earth cuts may be used for vertical forms for footings below ground where the ground stands vertical and is approved by the Owner's testing agency prior to placement of concrete.

2.2.2.5(e) Construction joints shall be located such that the maximum placement length of a continuous concrete wall will not exceed 100 feet in any one day.

2.2.3.2 Form ties for exposed-to-view concrete walls shall leave a 1 in. diameter cone hole. The holes shall be left open or epoxy mortared at the discretion of the Architect. The ties shall be one of the following:

(a) Stainless steel "snap-ties" with a 1 in. break back.
(b) Galvanized "coil-bolt" type tie.
(c) "She-bolt" tie with the inner male unit galvanized.
(d) Other removable type tie with approval of the Architect.

2.3.1.2(a) Exposed edges of columns, walls, slabs and beams shall have 3/4 in. bevels, unless otherwise noted.

2.3.1.5(a) Concrete construction tolerances, even portions above 100 feet in elevation, shall be in accordance with ACI 117 with the following exceptions:

1. Variation in concrete edges supporting masonry and surfaces behind masonry and glass curtain wall shall not exceed plus or minus 1/2 in. from theoretical plan dimension.
2. Variation of beam soffit supporting masonry shall not exceed plus or minus 1/2 in. from theoretical elevation.
3. The class of surface for offset between adjacent pieces of formwork facing material shall be Class A for all surfaces exposed to view, and class C for all surfaces not exposed to view when the project is complete. Refer to 5.3.3.7 for ribbed slabs formed with metal pans.
4. Tolerances for placing anchor bolts and other embedded items for structural steel work (Section 051200) shall be in accordance with the AISC Code of Standard Practice for Steel Buildings and Bridges.

2.3.1.5(b) A preconstruction meeting shall be arranged by the Contractor for the purpose of reviewing critical tolerances, methods of making measurements, and the basis for acceptance or rejection of completed work to avoid misunderstandings at the time of final acceptance.

2.3.1.6(a) If required, retighten forms and bracing after concrete placement, but before concrete has taken its initial set, to eliminate mortar leaks and maintain proper alignment.

2.3.1.12(a) All sleeves, inserts and embedded items required by mechanical trades shall be furnished and placed by the appropriate mechanical contractor. All other sleeves, inserts, reglets, dovetail anchor slots, anchors and embedded items shall be furnished by the appropriate supplier and placed by the Contractor performing the work of this Section.

2.3.1.12(b) Sleeves, inserts, anchors and embedded items not shown on structural drawings must be approved by Architect/Engineer before placement of concrete.

2.3.1.14(a) Remove chips, wood, sawdust, dirt and debris just before concrete is placed.

2.3.1.18 Provisions for Other Trades: Provide openings in concrete and concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms. Size and location of openings, recesses and chases not shown on structural drawings must be approved by Architect/Engineer before placement of concrete.

2.3.2.4(a) Forms may be removed when the in-place concrete reaches the specified 28-day compression strength, or when the concrete reaches 75% of the specified 28-day compression strength and is no less than 7 days old. The 7-day minimum age requirement may be waived pending review of the proposed mix designs, forming systems, reshoring procedures and in-place concrete strengths.

2.3.3.4(a) Reshoring is required for multistory construction. The Architect/Engineer has the prerogative of disallowing any specific procedures the Architect/Engineer considers to be deleterious to the performance of the structure in its completed form.

2.3.3.4(b) The attention of the Contractor is directed to the following:

1. Live load and superimposed dead load capacities of each level are noted on the Drawings. Live loads are typically reduced per the building code for the design of beams and girders.
2. In general, the weight of newly placed concrete for a level, plus adequate construction load allowance, will exceed the combined live and superimposed dead load capacity of the level below.
3. When shores or reshores must extend to the ground to provide the required load-carrying capacity, the floors above the ground shall not be considered contributory to the shoring and reshoring capacity.

2.3.4.2(b)1 When Windsor Probe tests are used to evaluate the in-place strength of the concrete for form removal, the tests shall be performed by an approved testing agency in accordance with ASTM C803, with at least one test for each 1800 square feet of elevated structure. Windsor Probe tests shall be correlated to laboratory cured cylinders or drilled cores of the same material and mix-design to be tested.

2.3.4.3 Forms may not be removed until the actual in-place strength of the concrete is demonstrated by field-cured test cylinders, Windsor Probes, pullout tests, or the maturity method (ASTM C1074), regardless of the results of tests on laboratory-cured cylinders. These additional test cylinders or other tests shall be arranged and paid for by the Contractor.

Section 3 (ACI 301) - Reinforcement and Reinforcement Supports

3.1.3.1(a) Protect reinforcement surfaces from contact with soil, oil, formwork release agent, or other materials that decrease bond to concrete.

3.2.1.1(a) All reinforcing steel shall have a minimum F_y of 60 ksi. In addition, all reinforcing steel to be welded shall meet ASTM A706 and have a maximum carbon equivalent of 0.45%.

3.2.1.2(b)1 Provide epoxy coated steel where shown on the Drawings.

3.2.1.2(b)2 Epoxy coating shall be applied in plants certified in accordance with the CRSI Epoxy Coating Plant Certification Program.

3.2.1.2(b)3 Since the epoxy coating is flammable, the coated bars shall not be exposed to any fire or flame. Cutting coated bars by burning will not be permitted.

3.2.1.2(b)4 Repairs of coatings on epoxy coated bars and coated accessories shall be made at all breaks, abrasions, etc. exceeding an area of 0.01 sq. in., and at cut ends.

3.2.1.2(b)5 Every reasonable effort shall be made to repair all damaged areas of epoxy-coated reinforcing steel and accessories before any rusting occurs. If infrequent and small damaged areas do rust, the rust shall be thoroughly removed by media blasting or other approved method before the areas are repaired. The Contractor shall exercise care to ensure that coated bars, when incorporated into the work, are free from dirt, paint, oil, grease, or other foreign substances. The Architect/Engineer reserves the right to require cleaning of the reinforcement without additional compensation due the Contractor. It is the intent of this specification that an entirely rust-free and completely coated steel reinforcement system be provided before the concrete is placed. Placing of concrete shall be performed with methods and equipment that will not damage the coated materials.

3.2.1.2(b)6 Epoxy coating field patching material shall conform to ASTM A775 or ASTM A934 as applicable and shall be approved in writing by the epoxy coating manufacturer. The patching material shall be applied in accordance with the manufacturer's written instructions.

3.2.1.7(a)1 Welded wire reinforcement shall be in accordance with ASTM A1064 (smooth wire) unless noted otherwise on the Drawings. Furnish in flat sheets.

3.2.1.9(a) All clips, chairs, bars, and bar supports and other metallic materials used for installation or support of epoxy-coated reinforcing shall be entirely coated with epoxy or another polymer approved by the epoxy coating manufacturer.

3.2.1.9(b) Bar supports touching forms in concrete exposed to view, exterior or interior, shall be stainless steel, except use plastic or epoxy coated bar supports where bars are epoxy coated. Provide bar spacers for reinforcement in all walls.

3.2.1.10(a) Mechanical and welded splices of reinforcing steel shall be in accordance with ACI 318 and ACI 439.3R and approved by the Architect/Engineer.

3.2.1.11 Tie wire for holding reinforcing steel in position for Architectural Concrete shall be stainless steel except where bars are epoxy coated. Tie wire for all epoxy-coated bars shall be mylar or plastic-coated. Typically, ends of tie wire shall have a minimum of 1 in. clear distance to face of concrete.

3.2.1.16 Recycled content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content shall not be less than 60 percent.

3.2.2.2(a)1 Welding of reinforcing steel and welded wire reinforcement is not permitted without the approval of the Architect/Engineer.

3.3.2.8(e) Bending of reinforcing steel partially embedded in concrete is not permitted, unless otherwise detailed on the Contract Documents.

3.3.2.11 Placement of bars shall also be in accordance with the detailed recommendations given in the Concrete Reinforcing Steel Institute's "Placing Reinforcing Bars", 10th Edition.

3.3.2.12 Provide material and placement of contingency reinforcement as noted on the drawings. Bars are to be cut, bent and placed as directed by the Architect/Engineer as extra reinforcement without additional cost.

Section 4 (ACI 301) - Concrete Mixtures

4.1.1.1 The ready-mix concrete producer is completely and solely responsible for the design, production, and delivery of the concrete mixes to satisfy this Specification. The Contractor shall coordinate the review of the mix designs between the Ready-Mix Producer, Forming Contractor, and Placing/Finishing Contractor. The Contractor is responsible for informing the Ready-Mix Producer of the conditions at the job site, such as methods being used for placing concrete. Adjustments required to facilitate placing and achieve the desired results shall fall within the criteria of this Specification and shall be at no additional cost to the Owner. All mix designs and proposed adjustments to the same shall be submitted to the Architect/Engineer for review.

4.1.5 Regional Materials:

4.1.5.1 Concrete shall be manufactured within 500 miles of Project Site.

4.2.1.1(a)1 Cement for all concrete shall be ASTM C150, Type I or Type II, or ASTM C595, Type IL, unless otherwise noted. Air-entrained cement shall not be used. Air requirements shall be met by use of separate admixtures.

4.2.1.1(d)1 Class C and Class F fly ashes shall comply with ASTM C618, except that in addition to the requirements of ASTM C618, Type F fly ash shall have a maximum Loss on Ignition of 3%, with a maximum variation of 1%. Contractor's mix design submittal for mixes which include fly ash must be accompanied by complete chemical and physical analyses and quality control records for the proposed fly ash source for at least two years immediately prior to the proposed use on this project.

4.2.1.1(d)2 When fly ash is used, the ratio of fly ash to total cementitious materials shall be not less than 15% and no greater than 25%.

4.2.1.1(e)1 Ground granulated blast-furnace slag shall be Grade 100 or Grade 120 per ASTM C989.

4.2.1.1(e)2 When ground granulated blast-furnace slag is used, the maximum amount shall be limited to 40% by weight of the total cementitious materials.

4.2.1.2(a) All normal weight aggregates shall be graded, a mix of fine, intermediate, and coarse aggregates, and shall also conform to Kentucky Transportation Cabinet (KYTC) 601.02 as required for superstructures.

1. Aggregate certification submittal shall include copies of test reports on the proposed fine, intermediate, and coarse aggregates showing source of the materials and conformance with specification requirements. Tests shall be performed by a testing laboratory acceptable to the Architect/Engineer. Date of test(s) shall not be more than six months prior to date of submittal. Contractor shall furnish similar copies, of current date, when there is a

change in source of material and at any time upon demand by the Architect/Engineer.

4.2.1.3(a) Concrete mixer washout water shall not be used in any concrete except Backfill Concrete.

4.2.1.4.2(a) Calcium chloride, or admixtures containing more than .05% calcium chloride ions are not permitted. Written conformance to this requirement and the chloride content is required from the admixture manufacturer prior to mix design review.

4.2.1.4.3 High-range water-reducing admixture (superplasticizer) conforming to ASTM C494, Type F or G shall be used in all concrete with a specified maximum water-cementitious materials ratio below 0.42. The admixture may also be used at Contractor's option in other mixes, with the written approval of the Architect/Engineer, at no additional cost to the owner.

4.2.1.4.4 Water-reducing, non-chloride, non-corrosive, accelerating admixture conforming to ASTM C494, Type C or E, shall be used when early initial set is required. The admixture must have non-corrosive test data of a year's duration from an independent testing laboratory using an acceptable, accelerated corrosion test method such as that using electrical potential measures.

4.2.1.4.5 Water-reducing, retarding admixture conforming to ASTM C494, Type D shall be used when delay of the setting time for concrete is required.

4.2.1.4.6 Extended set-control admixtures, if used shall be added to the concrete during or immediately after the batching process. The dosage rate for each Mix Type shall be pre-determined by trial mixtures in which the admixture is added to a minimum 8 cu. yd. batch.

4.2.1.4.7 All admixtures shall be approved by the cement manufacturer.

4.2.1.6(a) Materials used for exposed concrete shall be furnished from the same source throughout the project unless otherwise approved by the Architect/Engineer.

4.2.2.2(a) Concrete shall be produced to have a maximum slump at the point of placement of 4 inches with a tolerance of one inch. This maximum slump may not be exceeded except by the addition of high-range water-reducer (superplasticizer). In those portions of the structure where member dimensions or congestion due to reinforcing steel prevent the proper placement and consolidation of the concrete at the maximum slump specified, superplasticizer shall be used by the Contractor in lieu of increasing the slump by the addition of water. Approved mix designs, with smaller size aggregates, may also be used in congested areas to facilitate concrete placement.

1. When superplasticizer is added at the site the maximum pre-adjusted slump shall be 4" and the maximum superplasticized slump shall be 8".

4.2.2.4(c)1 For pumped concrete, air content shall be periodically tested at both the truck discharge and end of hose. The required air content for acceptance at the truck discharge shall be adjusted, if necessary, to account for loss of air content during pumping.

4.2.2.4(d)1 Tolerance on air content for slabs that receive a trowel finish shall be +0.5%, -1.5%.

4.2.2.5(b) Maximum concrete temperature at time of discharge shall not exceed 95 °F. If necessary, use nitrogen cooling to maintain concrete temperature.

4.2.2.7(d)1 Chloride ion concentration - Maximum water-soluble chloride ion concentrations in hardened concrete at an age of 28 to 42 days contributed from all ingredients, including water, aggregates, cementitious materials and admixtures shall not exceed the limits indicated in Table 4.2.2.8(b). Immediately after receipt of contract, Contractor shall test proposed individual concrete ingredients for total chloride ion content. If the total chloride ion content calculated on the basis of the proposed concrete mix proportions exceeds the specified limits, it will be necessary to test hardened concrete samples of the proposed mix for water-soluble chloride ion content. If these test results exceed the specified limits, it will be necessary to vary ingredients and material sources and retest until specified limits are met.

a. Testing shall be performed by an independent testing laboratory employed and paid by the Contractor following ASTM C1218 test procedures.

4.2.2.8(b) Strength - Minimum concrete strengths shall be in accordance with Table 4.2.2.8(b). Note that some mixes may be specified with compressive strength requirements at other than 28 days.

Table 4.2.2.8(b) - Mixes and Locations

MIX TYPE	LOCATION	SPECIFIED STRENGTH (psi at days) (1)	MIN. PORTLAND CEMENT (lb. / cu. yd.) (2)	MAX % OF CHLORIDE BY WEIGHT OF CEMENT	MAX W/CM RATIO (7)	AIR % (1,3)	AGG. SIZE (4)
A	Foundations: Footings, drilled piers, pier caps, grade beams	4000 at 28	520	0.30	0.50	-	No. 57, 1 in.
B	Elevated beams, joists and slabs, columns as noted in the column schedule, and building foundation walls	5000 at 28	565	0.30	0.45	-	No. 57, 1 in.
C	Exterior Concrete	5000 at 28	600 (5)	0.15	0.40	6 +/- 1.5	No. 57, 1 in.
D	Interior slabs on grade, interior slabs on metal deck, and all concrete U.N.O.	4000 at 28	520	0.30	0.50	-	No. 57, 1 in.
E	Columns as noted in column schedule	7000 at 56	675 + 125 fly ash (6)	0.30	0.40	-	No. 57, 1 in.
F	Stair pan fills	3000 at 28	500	0.30	0.50	-	No. 8, 3/8 in.

MIX TYPE	LOCATION	SPECIFIED STRENGTH (psi at days) (1)	MIN. PORTLAND CEMENT (lb. / cu. yd.) (2)	MAX % OF CHLORIDE BY WEIGHT OF CEMENT	MAX W/CM RATIO (7)	AIR % (1,3)	AGG. SIZE (4)
G	Backfill concrete	1500 at 28	280	1.0	-	-	No. 57, 1 in.
H	Linacc vault walls and roof	3000 at 14 5000 at 56	540	0.30	0.45	-	No. 467, 1 1/2 in.

NOTES:
1. Concrete which is placed and does not meet strength or air content requirements shall be removed and replaced at no cost to the Owner.
2. Including fly ash or ground granulated blast-furnace (GGBF) slag in mixes where permitted. Not applicable if a specified minimum amount of fly ash or GGBF slag is listed with the mix. The minimum cement requirement may be met by substituting 1.33 lb. of fly ash for each 1.0 lb. of portland cement replaced, or 1.0 lb. of GGBF slag for each 1.0 lb. of portland cement replaced. The ratio of fly ash to total cementitious materials shall be no less than 15% and no greater than 25%; the ratio of GGBF slag to total cementitious materials shall be no greater than 40%; and the total of fly ash and GGBF slag shall be no greater than 50% of total cementitious materials.
3. Tolerance on entrained air content shall be as delivered.
4. Normal weight aggregate unless indicated lightweight (LW) concrete at 117 lb. / cu. ft.
5. Fly ash not permitted in this mix.
6. Fly ash can be omitted from this mix if minimum 25% of the cement content is replaced with GGBF slag.
7. Maximum w/cm ratio shall be based on the final total cementitious content submitted by ready-mixed producer.

4.2.3.5(a) Mix designs incorporating superplasticizer must be accompanied by test results from cylinders made from trial batches or field test data in which the superplasticizer was added to a minimum 8 cu. yd. batch in a truck mixer.

4.3.1.1(a) Site produced concrete is prohibited.

4.3.1.4 When a high-range water-reducer (superplasticizer) is added at the site it shall be premeasured and added in accordance with the manufacturer's written instructions and specifications, using truck-mounted power injection equipment capable of rapidly and uniformly distributing the admixture to the concrete. The concrete shall be mixed for a minimum of six minutes after addition of the superplasticizer prior to discharge.

4.3.2.1(a) Slump adjustment: When concrete arrives at the project with slump below that suitable for placing, and below the slump specified, water may be added only if neither the maximum water-cementitious materials ratio nor the maximum slump is exceeded, provided that:

1. The approved mix design has allowed for the addition of water on site.
2. The amount of water added at the site is accurately measured to plus or minus 1 gallon of the desired added amount.
3. The water addition is followed by 3 minutes of mixing at mixing speed prior to discharge.
4. Standard cylinder samples as required by these Specifications are taken after addition of water.

5. The person authorized to add water shall be mutually approved by Architect/Engineer, Contractor, Construction Manager and Ready-Mix Producer.

4.3.2.1(b) Do not add water to concrete after high-range water-reducing admixtures have been added.

4.3.2.1(c) The maximum water-cementitious materials ratio is defined as that of the mix design furnished by the ready-mix producer. (Not to exceed values noted in Table 4.2.2.8(b)).

4.3.2.1(d) Concrete arriving at the site above the maximum slump shall be rejected.

4.3.2.1(e) Addition of cement, except as part of initial batching at the plant in accordance with an approved mix design, is prohibited.

4.3.2.2(a) The concrete must be discharged from the ready-mix trucks within 1-1/2 hours after the introduction of mixing water to the cement and aggregates.

1. During hot weather or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required. When air temperature is between 85 °F (30 °C) and 90 °F (32 °C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 °F (32 °C) reduce mixing and delivery time to 60 minutes.

4.3.2.3 Furnish to the Project Superintendent 2 delivery tickets with each load of concrete. Tickets shall contain the following information.

(a) Date.
(b) Producer and plant.
(c) Job.
(d) Contractor.
(e) Truck No. and time dispatched.
(f) Concrete designation and cement type.
(g) Admixtures description and content.
(h) Time discharge started and completed.
(i) Amount of concrete in load.
(j) Amount of water in mix at plant.
(k) Amount of any material added at the site and authorized signature.

Section 5 (ACI 301) - Handling, Placing and Constructing

5.1.2.1(d)1 Notify the Architect/Engineer at least two working days prior to placing concrete.

5.1.2.1(d)2 No concrete shall be placed without Owner’s Testing Agency being present. Give due notice to the Architect/Engineer and all Contractors affected before placing concrete. Allow adequate time for installation of all necessary parts.

5.2.1.1(a) Water used for curing exposed surfaces shall be free of substances that will stain or discolor concrete.

5.2.1.2 Curing Compounds:

(a) Curing Compound for unformed surfaces that will not receive a coating or bonded floor covering shall conform to the requirements of ASTM C1315, Type I, Class A.
(b) Curing Compound for formed surfaces, and unformed surfaces that will receive a coating or bonded floor covering, shall be a dissipating or removable curing compound that conforms to ASTM C309. Furthermore, the curing compound shall be approved in writing by the manufacturers of all coatings, floor coverings and surface treatments used on the project. Confirm types and locations of coatings, flooring, and surface treatments with Architect.
(c) Curing compound(s) shall comply with all applicable environmental and clean air regulations for the community in which this Project is located.

5.2.1.3 Waterproof curing sheets shall comply with ASTM C171. Prior approved materials:

(a) Orange Label Sisalkraft paper manufactured by the Fortifiber Building Systems Group.
(b) Polyethylene film, minimum 8 mils thickness. Except do not use on surfaces that will be left exposed to view when the project is complete.
(c) BurLene curing blankets manufactured by the Max Katz Bag Company, Inc.

5.2.1.7(a) Epoxy bonding agent shall comply with ASTM C881, Type V, Grade 2, with Class corresponding to temperature at time of pour.

5.2.1.7(b) Latex bonding agent shall comply with ASTM C1059, Type II.

5.2.1.10 Related materials for concrete construction shall be as follows:

5.2.1.10(a) Vapor retarder under interior slabs-on-grade: Minimum 15 mils thick, puncture resistant, high tensile strength plastic sheet material meeting ASTM E1745, Class A requirements. Include manufacturer’s pressure sensitive tape and mastic.

5.2.1.10(b) Non-slip Aggregate used as the abrasive aggregate for a non-slip floor finish shall be fused aluminum oxide grits, or crushed emery. Emery aggregate shall contain not less than 40% aluminum oxide nor less than 24% ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

5.2.1.10(c) A floor sealer shall be used where shown on the architectural contract documents. The compound shall be a V.O.C. compliant water-based, non-yellowing acrylic sealer. Apply according to manufacturer’s recommendations.

5.2.1.10(d) Non-shrink grout shall have a minimum compression strength of 7000 psi at 28 days and be a non-shrink, non-metallic, non-staining, non-corrosive, premixed grout. Comply with ASTM C1107.

Prior approved grouts:
1. Dayton Superior Sure-Grip High Performance Grout
2. Euclid Hi Flow or NS Grout
3. Master Builders MasterFlow 713 or MasterFlow 928 grout

5.2.1.10(e) Neoprene bearing pads shown on drawings shall be 100% virgin chloroprene (Neoprene) and shall meet AASHTO specifications. Shore "A" hardness shall be 60 unless otherwise noted. Submit certification and test reports for the actual production run of these pads as part of the shop drawing submittal procedure.

5.2.1.10(f) Ledge Angle Inserts and Bolts:

1. Inserts shall be wedge type inserts. The main body of the insert shall have an overall height of at least 3-7/8 in. and provide a minimum 1-3/4 in. vertical adjustment for 3/4 in. diameter askew head bolts. The inserts shall have an attached anchor loop that projects at least 2-1/2 in. behind the body of the insert.
2. The insert supplier shall certify the inserts will simultaneously support a vertical load of 1000 pounds and a pullout load of 1600 pounds with a safety factor of 3. Vertical slip shall not exceed 1/16 in. Certification must be accompanied by test results from an independent testing agency.
3. Bolts shall be ¾ in. diameter Askew Head Bolts supplied by the insert manufacturer, of a length required to meet the capacity requirements shown above, including all concrete construction tolerances, shims, etc.
4. Steel shims shall be provided as detailed on the Drawings. Shims shall be "U-shaped" and shall fully bear against the concrete surface.
5. Inserts, bolts, nuts, washers and shims are to be hot-dipped galvanized in accordance with ASTM A153.
6. Submittals required by Insert Manufacturer:
    a. Installation instructions indicating the following:
        1) Minimum air temperature restrictions, if any, for torqueing bolts.
        2) Specified torque to obtain a factor of safety of 2 against slip between angle, shims and insert.
        3) Any special instructions regarding proper installation of proposed insert.
    b. Test data for insert furnished indicating shear and pullout capacity of insert.
    c. Certification as described herein.
7. Inserts shall be installed with a minimum of 1-1/2 in. of concrete below the insert.
8. See details on Drawings for additional information.

5.2.1.10(h) Dovetail Anchor Slots: 22 gauge minimum, G60 galvanized. Provide where masonry is backed by concrete. Maximum horizontal slot spacing is 16 in. c/c. Refer to architectural drawings.

5.2.1.10(i) Epoxy Adhesive:

1. Two-component, high modulus, high strength, structural epoxy adhesive for use in installing reinforcing steel dowels into hardened concrete.
2. ASTM C 881, Type IV, Grade 3 with class corresponding to temperature at time of placement.

5.3.1.3(d) Verify position and securement of embedded items before placing concrete.

5.3.1.4(a)1 Following approval of prepared subgrades by Soils Technician, spread and compact granular base course to 100% maximum dry density as determined by standard Proctor Method ASTM D698.

5.3.1.4(c) At all interior slabs-on-grade install vapor retarder over base in accordance with ASTM E1643 with all joints lapped 6 inches minimum and taped. Protect from damage during subsequent operations until concrete is placed. If surface of base is rough, place 1/2 in. of fine graded, compacted material over base before installation of vapor retarder. Vapor retarder to be continuous at turned down slabs from lower to higher slab elevations. Do not place vapor retarder under exterior slabs-on-grade.

5.3.1.5(a) Make provisions in advance for wind-breaks, shading, fogging, sprinkling, ponding, or wet curing as dictated by conditions at time of concrete placement.

5.3.1.7 Discharge of concrete from ready-mix trucks shall not begin until testing agency has made preliminary checks of slump (and air content - if required).

5.3.2.1(a)1 Adequate protection against rain, sleet or snow shall be defined as protection that prevents any and all adverse affects of the rain, sleet or snow on the appearance, strength or durability of the concrete.

5.3.2.1(b)1 Placement of concrete in cold weather shall also comply with Article 1.9 of this specification, titled Cold Weather Concreting.

5.3.2.1(c)1 Placement of concrete in hot weather shall also comply with Article 1.10 of this specification, titled Hot Weather Concreting.

5.3.2.1(d) Evaporation Retarder - When low humidity and/or dry winds create conditions suitable for plastic cracking, evaporation retarder may be required to be applied by spray one or more times during the finishing operation. Evaporation retarder shall not be used as a finishing aid.

5.3.2.3(c)1 Pumping pipes and hoses shall be supported above in-place reinforcing on plywood or tires to cushion impacts, prevent abrasions of epoxy coatings and PT sheathing, and prevent displacement of reinforcement.

5.3.2.4(i) Assume 1/2 in. average extra concrete will be required to account for deflection of metal deck.

5.3.2.4(j) Concrete is not permitted to be placed in standing water or under water without approval of Architect/Engineer.

5.3.2.6(d) Bond is required for vertical construction joints in horizontal members, except for slabs on grade.

5.3.3.3(a) *Surface finish-1.0* (SF-1.0):

1. No formwork facing material is specified.
2. Patch voids larger than 1-1/2 in. wide or 1/2 in. deep.
3. Remove projections larger than 1/2 in.
4. Tie holes need not be patched.
5. Surface tolerance Class C as specified in ACI 117.
6. Mockup not required.

5.3.3.3(b) *Surface finish-2.0* (SF-2.0):

1. Patch voids larger than 3/4 in. wide or 1/2 in. deep.
2. Remove projections larger than 1/8 in.
3. Patch tie holes unless indicated otherwise in Contract Documents.
4. Surface tolerance Class A as specified in ACI 117.
5. Mockup not required.

5.3.3.3(c) *Surface finish-3.0* (SF-3.0):

1. Patch voids larger than 3/4 in. wide or 1/2 in. deep.
2. Remove projections larger than 1/8 in.
3. Patch tie holes unless indicated otherwise in Contract Documents.

4. Surface tolerance Class A as specified in ACI 117.
5. Provide mockup of concrete surface appearance and texture.

5.3.3.4(b)1 Where a grout-cleaned rubbed finish is indicated, grout color shall match color of concrete surface to which the grout is applied. When the color of the grout lightens due to drying, rub the surface and keep the surface damp for 36 hours afterward.

5.3.3.4(c)1 Where a cork-floated finish is specified, grout color shall match color of concrete surface to which the grout is applied.

5.3.3.7 Specified Finishes of Formed Surfaces:

(a) NON-EXPOSED SURFACES shall be SF-1.0 per 5.3.3.3(a). This includes all non-exposed flat surface and ribbed slabs. Metal pans shall be new or factory reconditioned, with stiffeners to support concrete without sags and bulges in order to satisfy a Class D surface tolerance per ACI 117.

(b) EXPOSED SURFACES shall be SF-2.0 per 5.3.3.3(b). Vertical surfaces to be cast against Class 1 High Density Overlaid Plyform (HDO – Concrete Form) true to line. Slab and beam soffits to be cast against Class 1 HDO Plyform or Class 1 Medium Density Overlaid Plyform (MDO – Concrete Form). This finish applies to all exposed to view formed surfaces that are not designated Architectural Concrete, both interior and exterior.
   1. Formwork shall be in 8-foot lengths and 4-foot widths unless otherwise noted.

(c) ARCHITECTURALLY EXPOSED SURFACES shall be SF-3.0 per 5.3.3.3(c) cast against Class 1 High Density Overlaid Plyform (HDO – Concrete Form) true to line, unless specified otherwise in Section 6 (ACI 301). This finish applies to all formed surfaces exposed to view which are designated Architectural Concrete, both interior and exterior.
   1. Material and layout must be approved by Architect prior to placing concrete.
   2. Formwork shall be in 8-foot lengths and 4-foot widths unless otherwise noted.

5.3.3.8 In the case of disagreement regarding use of damaged or worn formwork impairing the concrete surface the Architect's decision shall be final.

5.3.4.2.1 Slabs shall be finished in accordance with 5.3.4.2(i) 'Unspecified unformed surface finishes' (as described in ACI 301), unless indicated otherwise on the architectural drawings or in 5.3.4.2(j).

5.3.4.2(c)1 Do not apply a 'hard-troweled' finish to air-entrained concrete specified to receive a 'trowel' finish.

5.3.4.2(c)2 Rider-operated floats and trowels shall not be used on air-entrained concrete specified to receive a trowel finish.

5.3.4.2(j) Specified Finishes of Unformed Surfaces:

Type A Exterior areas exposed to vehicular or pedestrian traffic to receive a floated or light broom finish per the Architect's direction. Finish slabs to a manual straightedge 'conventional' tolerance per ACI 117 (1/2 in. in

10 feet) and provide positive drainage with no “ponds” greater than 6 in. in diameter. Do not “over finish” slabs.

Type B Building interior slabs-on-grade and supported decks and all other slabs not specifically indicated shall receive a steel trowel finish in accordance with 5.3.4.2(c). Finish slabs to a ‘flat’ tolerance (SOF_F=35, MLF_F= 28, SOF_L=25, MLF_L=20) in accordance with ACI 117. Measure floor finish tolerance within 72 hours after floor finishing and before removal of supporting formwork or shoring. Levelness tolerance (SOF_L) is not applicable to un-shored suspended floors.

Type C Slabs to receive future waterproofing membrane or insulation with topping slabs shall have a floated finish in accordance with 5.3.4.2(b).

Type D Slabs to receive future topping slabs bonded to base slab shall be finished in accordance with 5.3.4.2(f).

Type E Stair treads and landings, interior or exterior, shall receive a non-slip floated finish with a non-slip aggregate finished to a manual straightedge ‘flat’ tolerance per ACI 117 (1/4 in. in 10 feet).

5.3.4.2(j)1 Unformed surfaces which do not comply with the specified tolerances, and are deemed unacceptable by the Architect or installer of subsequent floor covering(s), shall be remedied by the Contractor in a manner acceptable to the Architect at no additional cost to the Owner.

5.3.5.1 Where not otherwise shown on Drawings, provide control joints in slabs on grade at column centerlines and at the following maximum spacing:

(a) Slabs less than 5 in. thick – 12 ft. c/c
(b) Slabs 5 in. to 8 in. thick – 16 ft. c/c
(c) Topping slabs – 8 ft. c/c
(d) Maximum panel width-to-length ratio: 1.5.

5.3.6.4(a) When forms are removed prior to 7 days, apply one coat of liquid curing compound to all formed surfaces within an hour of formwork removal.

5.3.6.5(e)1 A thin layer of water shall be applied to the slab surface just prior to placement of the waterproof sheet. The sheet shall remain in place for a minimum of 7 days. All edges and laps of the waterproof sheet shall be weighted down. All tears in the sheet shall be immediately repaired and the concrete surface re-wetted so that no portion of the concrete surface remains uncovered and all portions of the concrete surface remain continuously moist.

5.3.6.5(f)1 Apply curing compound to flatwork in two coats at right angles to each other per manufacturer’s recommendations. Total application rate shall be in accordance with manufacturer’s recommendations, but not less than 1 gal./200 ft^2. For rough surfaces, such as broom or scratch finishes, increase application rate per manufacturer’s recommendations, but by not less than 50%.

a. Correct coverage shall be maintained by the applicator and determined through accurate measurement of the material and the number of square feet to which it is applied.

b. Curing compound shall also be applied to formed surfaces, including beam and slab soffits, per manufacturer's recommendations when forms are removed sooner than 7 days after concrete is cast.

5.3.6.5(g) Unless otherwise noted, preservation of moisture in concrete shall be by application of a curing compound satisfying the requirements of 5.2.1.2. Apply the curing compound in accordance with 5.3.6.5(f)1.

5.3.6.5(h) Where curing compound will not be compatible with applied finishes or is not permitted because of proximate occupancy, application of water-retention sheeting materials per 5.3.6.5(e) or a continuous wet cure per 5.3.6.5(a), 5.3.6.5(b), 5.3.6.5(c) or 5.3.6.5(d) is required. Apply water-retention sheeting materials or wet cure all slabs to receive a bonded topping or bonded waterproof membrane. Wet cure slabs shown on the architectural drawings as requiring a wet cure.

5.3.7.1(a) All voids, damaged places, fins, projections, and honeycomb areas shall be removed down to sound concrete and repaired immediately after form removal. Any concrete that is not formed as shown on the contract drawings, is out of alignment or level, or indicates a defective surface or unsoundness of any nature shall be removed and replaced to the limits required by the Architect/Engineer unless permission is granted to patch or otherwise correct the defective work. Permission to patch or attempt the correction shall not be construed as a waiver of the Architect/Engineer's right to require complete removal of the defective work should the patching or correction prove to be, in the opinion of the Architect/Engineer, unsatisfactory either as to structure or appearance.

5.3.7.2(a) Grout tie holes with non-shrink grout in below-grade walls. Coat the applied area with the specified bonding agent per the manufacturer's instructions. **Do not grout tie holes in exposed to view walls unless otherwise noted**.

5.3.7.5(a) Repair materials other than site-mixed portland-cement mortar shall be submitted for approval.

5.3.7.7 All patching materials shall be proportioned to match color of surrounding material after patch material has cured. Prior to starting patching operation, test different techniques, grout mixes, and curing procedures on concealed areas to best match cast concrete. Obtain approval from the Architect/Engineer of patching material and methods prior to proceeding with patching.

Section 6 (ACI 301) – Architectural Concrete

6.1.1.1 Surfaces designated as Architectural Concrete on the Drawings shall comply with section 6 of ACI 301.

6.1.1.2 Refer to the architectural drawings for locations requiring special formwork or finishes; locations and size of form joints and ties; and location, size and profile of reveal patterns.

6.1.4.4(a)1 Preconstruction mock-ups shall be prepared at the site to demonstrate the Contractor's ability to form, place and achieve the architectural finishes specified.

6.1.4.4(b)1 Unless indicated otherwise on the drawings, wall mock-ups shall be minimum 12 feet long by 8 feet tall with full-scale thickness, and shall contain the following:

a. Horizontal construction joint
b. Vertical construction joint
c. Form ties
d. Rustications and bevels
e. Simulated repair area
f. Typical Reinforcing
g. Sealer or coating, if applicable

6.1.4.4(d) Accepted mock-ups shall be used as a standard for the Work. The mock-ups shall be kept intact and protected until directed by the Architect to be destroyed and debris removed from the site. A non-exposed-to-view concrete wall within the structure may be used as a mock-up panel with Architect's prior approval.

6.1.4.5(a)1 The Architect will periodically observe completed portions of architectural concrete for acceptance. The frequency of periodic acceptance shall be established and agreed upon in a preconstruction meeting arranged by the Contractor.

6.1.4.5(b)1 Architectural concrete declared un-acceptable during periodic observation requires submittal of a revised method of producing acceptable concrete before proceeding with additional architectural concrete construction.

6.2.1.8(c) Form ties for architectural concrete shall comply with 2.2.3.2.

6.2.2.1(e)1 To ensure that reused forms will not contain patches resulting from alterations, forms shall be reused only on identical sections.

6.2.2.1(f) Unless otherwise specified, formwork for architectural concrete finishes shall comply with SF-3.0 in accordance with 5.3.3.3(c).

Section 7 (ACI 301) - Lightweight Concrete

7.1.1 Delete this section of ACI 301.

Section 8 (ACI 301) – Mass Concrete

8.1.1.1 Concrete which is thicker than 4 feet in its minimum dimension for foundation concrete and thicker than 3 feet in its minimum dimension for concrete above grade, shall be subject to the provisions of this section.

8.2.1.2 Where necessary, use a retarding admixture conforming to ASTM C494, pretested with project materials under project conditions, to prevent cold joints or to help reduce the maximum temperature and rate of temperature rise of the concrete.

8.2.1.3 Do not use accelerating admixtures in mass concrete.

Section 9 (ACI 301) – Post-Tensioned Concrete

9.1.1.1 Delete this section of ACI 301.

Section 10 (ACI 301) – Shrinkage-Compensating Concrete for Interior Slabs

10.1.1 Delete this section of ACI 301.

Section 11 (ACI 301) – Industrial Floor Slabs

11.1.1 Delete this section of ACI 301.

Section 12 (ACI 301) – Tilt-Up Construction

12.1.1 Delete this section of ACI 301.

Section 13 (ACI 301) – Precast Structural Concrete

13.1.1 Delete this section of ACI 301. Where applicable, Precast Structural Concrete is specified in Specification Section 034100 – Precast Structural Concrete.

Section 14 (ACI 301) – Precast Architectural Concrete

14.1.1 Delete this section of ACI 301. Where applicable, Precast Architectural Concrete is specified in Specification Section 034500 – Precast Architectural Concrete.

END OF FOREGOING PARAGRAPH 1.8 ENTITLED "SUPPLEMENTAL REQUIREMENTS AND MODIFICATIONS TO ACI 301-16".

1.9 COLD WEATHER CONCRETING

A. The provisions of ACI 306.1 shall be followed for all concrete placed or cured when the average daily temperature is below 40 °F. The methods of protection to be used for cold weather concrete, including preservation of moisture for curing of the concrete, shall be submitted in writing to the Architect/Engineer for review at least one week prior to cold weather placement.

B. Plan construction schedule and obtain needed materials and equipment on the job site in advance of cold weather.

C. All reinforcement, formwork and top 12 inches of the subgrade shall be clear of ice and snow and be not less than 40 °F at time of placement of concrete. The temperature of large embedded items, such as weld plate assemblies for structural steel framing, shall be no less than 35 °F at time of placement.

D. The concrete temperature as placed shall not be less than specified in column (2) of Table 3.2.1 in ACI 306.1, and shall not exceed these values by more than 20 °F. The temperature of the concrete being discharged shall be tested by the testing agency whenever cylinders are cast, and hourly by the Contractor. The Contractor shall maintain and submit same to the Architect/Engineer weekly.

E. Any covering, insulation or housing shall be extended to protect projecting reinforcement and embedded items.

F. The Contractor shall install and read maximum/minimum thermometers twice daily during the construction and curing of all structural slabs in cold weather. Provide one thermometer for each 3000 square feet of slab. Place the thermometers near slab perimeter. The Contractor shall submit those temperature readings to the Architect/Engineer weekly.

G. Concrete shall be exposed to ambient temperature in a gradual manner after being cured. Refer to ACI 306.1, Table 3.2.1.

1.10 HOT WEATHER CONCRETING

A. The provisions of ACI 305.1 shall be followed for all concrete placed when the ambient air temperature is greater than 80 °F. Note: Concrete protection during windy conditions combined with heat or low humidity shall also conform to ACI 305.1. The methods of protection used for hot weather concreting shall be submitted in writing to the Architect/Engineer for review at least one week prior to hot weather placement.

B. Plan construction schedule and obtain needed materials and equipment on the job site in advance of hot weather.

C. The Contractor and ready-mix supplier shall review concrete mixes for use in hot weather with respect to placing requirements, strength and durability.

D. Concrete temperatures as discharged from the truck shall not exceed 95 °F. Ice, if used, shall be considered part of the total mix water (50 lbs. ice = 6 gallons of water). (Retarders in low slump superplasticized mixes may be required to comply with this requirement.)

E. The temperature of the concrete being discharged shall be tested by the testing agency whenever cylinders are cast, and hourly by the Contractor. The Contractor shall maintain a written record of these temperatures and submit same to the Architect/Engineer weekly.

F. Cool and moisten formwork and subgrade by sprinkling with water prior to placing concrete.

G. Placement and Finishing:

1. Concrete shall be discharged from the truck a maximum of one hour after the introduction of mix water to cement and aggregates.
2. Do not add water to mix to increase slump. Use the approved superplasticizer to maintain a placeable concrete mix.
3. Strike off and screed slabs immediately. Protect slab's surface against moisture loss prior to final finishing.
4. Thoroughly vibrate through all wall and column lift lines and adjacent slab placements to prevent cold joints.
5. Immediately apply liquid curing compound as specified in Section 5 (ACI 301) after final finishing. Follow with continuous wet curing as specified in paragraphs 5.3.6.5(a), 5.3.6.5(b), 5.3.6.5(c) or 5.3.6.5(d) (ACI 301) for a minimum of three days.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS ARE INCLUDED IN ARTICLES 1.8 THROUGH 1.10 ABOVE.

PART 3 - EXECUTION

3.1 EXECUTION REQUIREMENTS ARE INCLUDED IN ARTICLES 1.8 THROUGH 1.10 ABOVE.

END OF SECTION

SECTION 03 3010

CAST-IN PLACE CONCRETE (MINOR STRUCTURES)

PART 1 GENERAL

1.01 SUMMARY

A. This specification delineates the requirements for cast-in place concrete for minor structures including concrete kickers for pipe blocking, sidewalks, collars, manholes, manhole bottoms, pipe cradles, piers, and other areas where small quantities of concrete are required. It shall not be used for major structures such as floor slabs, structure or basin walls, roof slabs, or other structural components.

1.02 SCOPE OF WORK

A. Provide all labor, material, equipment, and services to complete all cast-in-place concrete work required by the Project as shown on the Drawings or specified herein.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	Specification for Steel, Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A 497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM A 615/A615M	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A616M	Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A617M	Specification for Axle-Steel Deformed and Plain End Bars for Concrete Reinforcement
ASTM A 706/A706M	Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM C 33	Specification for Concrete Aggregates

ASTM C 150 Specification for Portland Cement

ASTM C 260 Specification for Air-Entraining Admixtures for Concrete

ASTM C 494 Specification for Chemical Admixtures for Concrete

1.04 SUBMITTALS

A. Copies of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of the General Conditions.

1.05 QUALITY ASSURANCE

A. All work shall be performed to secure for the entire job homogeneous concrete having required strength, durability and weathering resistance, without planes of weakness and other structural defects and free of pronounced honeycombs, air pockets, voids, projections, offsets of plane and other defacements on exposed surfaces.

1.06 DELIVERY, STORAGE AND HANDLING

A. Do not deliver ready-mixed concrete to job site until ready for placement.

B. All materials used for on-site mixed concrete shall be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer.

C. Store concrete aggregates to prevent contamination or segregation. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting.

D. Protect from contaminants such as grease, oil, and dirt. Provide for accurate identification after bundles have been broken and tags removed.

1.07 PROJECT/SITE CONDITIONS

A. Cold Weather

1. Provide and maintain 50 degrees Fahrenheit minimum concrete temperature. Do not place concrete when ambient temperature is below 40 degrees Fahrenheit. Cover concrete and provide with a source of heat sufficient to maintain 50 degrees Fahrenheit minimum while curing.

B. Hot Weather

1. Concrete temperature from initial mixing through final cure shall not exceed 90 degrees Fahrenheit. Cool ingredients before mixing, or substitute chip ice for part of required mixing water or use other suitable means to control concrete temperature to prevent rapid drying of newly

placed concrete. Shade the fresh concrete and start curing as soon as the surface is sufficiently hard to permit curing without damage.

PART 2 PRODUCTS

2.01 CONCRETE

A. Mix Design

1. The concrete mix shall conform to the requirements of the following table according to the class of concrete required. The number in the "Class" column refers to the 28-day compressive strength of the concrete in pounds per square inch (psi).

Class	Minimum Cement Content (Lbs./Cu. Yd.)	*Maximum Slump (Inches)
3000	470	3 to 4
3500	520	3 to 4
4000	550	3 to 4

* Maximum slump unless high range water reducing admixture is used.

B. Area of Application

1. Unless otherwise noted on the Drawings, concrete mixes shall be used as follows:

Class 3000 - kickers for pipe, fittings
Class 3500 - non-reinforced portions of manholes, pipe cradles
Class 4000 - reinforced portions of manholes, sidewalks, piers

2.02 MATERIALS

A. Cement

1. Portland cement for concrete and mortar shall conform to ASTM C 150, Type I or II.

B. Water

1. Water shall be potable.

C. Aggregates

1. Aggregates shall conform to ASTM C 33. Obtain aggregates from one source. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalis in the cement.

D. Admixtures

1. Admixtures for air-entrained concrete shall conform to ASTM C 260, for water reducing (Type A, D or E) accelerating (Type C) and retarding (Type B or D) ASTM C 494. Calcium chloride shall not be used as an admixture. Admixtures shall not be used without prior written approval of the ENGINEER.

E. Reinforcement

1. Reinforcing Bars

a. Reinforcing bars shall conform to ASTM A 615/A615M Grade 60, ASTM A 616/A616M Grade 60, ASTM A 617/A617M Grade 60 or ASTM A 706/A706M Grade 60 as applicable.

2. Welded Wire Fabric

a. Welded wire fabric shall conform to ASTM A 497 or ASTM A 185.

PART 3 EXECUTION

3.01 FORMS

A. Forms shall be used to confine concrete and shape it to the required dimensions. Set forms true to line and grade and make mortar tight. Chamfer above grade exposed joints, edges, and external corners 3/4-inch, unless otherwise indicated. Earth cuts may be used as forms for footing vertical surfaces, if sides are sharp and true, and not exposed in finished structure.

3.02 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

A. Provide bars, wire fabric and other reinforcing materials, including wire ties, supports and other devices necessary to install and secure the reinforcement.

3.03 CONTROL AND CONSTRUCTION JOINTS

A. For sidewalks, provide control joints spaced at an interval equal to the width of the sidewalk, the minimum spacing of 5 feet. Cut joints 1 inch deep with a jointing tool after the surface has been finished. Provide 0.5-inch thick transverse expansion joints at changes in direction, where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space joints not more than 40 feet apart. Limit variation in cross section to 1/4-inch in 5 feet.

3.04 CURING AND PROTECTION

A. Protect concrete from injurious action by sun, wind, rain, flowing water, or mechanical injury. Do not allow concrete to dry out from time of placement until the expiration of the curing period. Forms may be removed 48 hours after concrete placement.

END OF SECTION

***

SECTION 040523 - ADJUSTABLE CONCEALED LINTEL SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Adjustable concealed lintel system and accessories, including spin system with mid-support if needed.

B. Support brackets to be attached to anchor channels or framing and mounting channels.

1.2 REFERENCE STANDARDS

A. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.

B. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

C. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

E. ASTM F568M – Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

F. AWS B2.1/B2.1M – Specification for Welding Procedure and Performance Qualification.

G. AWS D1.1/D1.1M – Structural Welding Code – Steel.

1.3 COORDINATION

A. Coordinate the Work with installation of component assembly into masonry components without interfering with masonry reinforcement.

B. Coordinate welding in accordance with AWS B2.1/B2.1M for mid-span support and HALFEN mounting and framing channels.

1.4 PREINSTALLATION MEETINGS

A. Convene pre-installation meeting 2 weeks before start of work of this section.

B. Require attendance of parties directly affecting work of this section, including Construction Manager, Contractor, Architect, Engineer, installer, and manufacturer’s representative.

C. Review materials, preparation, installation, tolerances, protection, and coordination with other work.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s product data, including project specific installation instructions.

B. Shop Drawings:

1. Submit manufacturer's project specific shop drawings, indicating component profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
2. Indicate welded connections using standard welding symbols.
3. Indicate net weld lengths.

C. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

D. Delegated-Design Submittal: Submit manufacturer's design data, including project specific structural calculations, shop drawings, and installation drawings, signed and sealed by qualified professional engineer registered in state of the installation. System is Delegated-Design for performance requirements and to include all fasteners to primary structure and 13% Tested Thermal Loss.

E. Warranty Documentation: Submit manufacturer's standard warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Capable of providing field service representation during installation.
2. Minimum of 5 years of experience in manufacture of adjustable concealed lintel system for masonry.
3. Experience in projects of similar scope.
4. Manufacture in accordance with established quality assurance program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage and Handling Requirements:

1. Store and handle materials in accordance with manufacturer's instructions.
2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
3. Store materials in clean, dry area indoors.
4. Protect materials and finish during storage, handling, and installation to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design Product: Subject to compliance with requirements, provide Halfen USA, Inc.; Adjustable Concealed Lintel System Assembly (FBRA-4) or comparable product by the following:

1. FERO Corporation; Custom Concealed Lintel Support System.
2. Hohmann & Barnard, Inc.; Concealed Lintel System.

2.2 MATERIALS

A. Adjustable Concealed Lintel System for Masonry:

1. Concealed Lintel Spines / Horseshoe Plates / Stitching Rods / Mid-span Support / Nuts and Bolts: Structural carbon steel, ASTM A36, then hot-dip galvanized, ASTM A123 or A153 as applicable.

2. Anchor Channels / Support Brackets / Stitching Rods / Nuts and Bolts: Structural carbon steel, ASTM A36, then hot-dip galvanized, ASTM A123 or A153 as applicable.

    a. Bolts and Nuts:

        1) Bolt-Type Fasteners: T-head, in contact with channel slot faces, carbon steel, ASTM F568M.
        2) Finish for Carbon Steel T-Bolts: Hot-dip galvanized, ASTM A123.
        3) Nuts: Carbon steel.

2.3 FABRICATION

A. Fabricate components to design required and provide for site-required adjustments.

B. Weld and grind components flush and smooth with adjacent finish surface.

1. Make exposed joints butt tight, flush, and hairline.
2. Ease exposed edges to small uniform radius.

C. Weld components indicated on shop drawings.

2.4 FINISHES

A. Structural Carbon Steel Components and Anchors: Hot-dip galvanized after fabrication, ASTM A123.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and supports to receive adjustable concealed lintel system.

B. Verify dimensions, tolerances, and method of attachment with other work.

C. Notify Architect of conditions that would adversely affect installation.

D. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

A. Supply items required to be placed in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install adjustable concealed lintel system in accordance with manufacturer’s instructions at locations indicated on the Drawings.

B. Install items plumb and level, accurately fitted, free from distortion or defects.

C. Adjust components to suit site conditions.

D. Provide formwork for placement in masonry to maintain true alignment until completion of permanent attachment.

E. Obtain approval from Architect and manufacturer before site cutting or making adjustments not scheduled.

F. Perform field welding in accordance with AWS D1.1/D1.1M where necessary using certified welders.

3.4 TOLERANCES

A. Maximum Variation from Level: 1/8 inch.

3.5 PROTECTION

A. Protect installed adjustable concealed lintel system from damage during construction.

B. Touch-up damage to factory-applied finishes using appropriate materials and techniques.

END OF SECTION 040523

SECTION 040524 - ADJUSTABLE BRICKWORK SUPPORT SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Adjustable Brickwork Support System and Accessories:

1. Support Bracket Types: As indicated on Drawings.
2. Individual Masonry Support Bracket Types: As indicated on Drawings.

B. Assembly provides steel components for adjustable support of brickwork above horizontal masonry joints and openings.

C. System attached to substrate by one of the following:

1. Cast-in channel anchors for attachment of adjustable brickwork supports:

a. Embedded Channel Type: Type HTA.
b. T-head adjusting bolts.
c. Washers.
d. Locking nuts.

2. Special Brackets and Applications:

a. Grouted-in-Wall Anchors: Type KM.

1.2 REFERENCE STANDARDS

A. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.

B. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

1.3 COORDINATION

A. Coordinate the Work with installation of adjustable brickwork support system connections onto structural supporting components.

1.4 PREINSTALLATION MEETINGS

A. Convene preinstallation meeting 2 weeks before start of work of this section.

B. Require attendance of parties directly affecting work of this section, including Construction Manager, Contractor, Architect, Engineer, installer, and manufacturer’s representative.

C. Review materials, preparation, installation, tolerances, protection, and coordination with other work.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data, including project specific installation instructions.

B. Shop Drawings: Submit manufacturer's project specific shop drawings, indicating component profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

C. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

D. Delegated-Design Submittal: Submit manufacturer's design data, including project specific structural calculations, shop drawings, and installation drawings, prepared, signed and sealed by qualified professional engineer registered in state of the installation. System is Delegated-Design for performance requirements and to include all fasteners to primary structures and 13% Tested Thermal Loss.

E. Warranty Documentation: Submit manufacturer's standard warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Capable of providing field service representation during installation.
2. Minimum of 5 years experience in manufacture of adjustable brickwork support system.
3. Experience in projects of similar scope.
4. Manufacture in accordance with established quality assurance program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage and Handling Requirements:

1. Store and handle materials in accordance with manufacturer's instructions.
2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
3. Store materials in clean, dry area indoors.
4. Protect materials and finish during storage, handling, and installation to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design Product: Subject to compliance with requirements, provide Halfen USA, Inc.; Halfen FK4 Adjustable Brickwork Support System Assembly (FBRA-3) or comparable product by the following:

1. FERO Corporation; FERO FAST Thermal Bracket System, consisting of FAST Thermal (Standard, Lintel, Inverted, TTS, Extended Clip Profiles, or other custom) Brackets, Rectangular Washers, Shim Rods, and a minimum of 3 Shim Plates per clip.

2.2 MATERIALS

A. Components of Adjustable Brickwork Support System:

1. Adjustable Brickwork Support System and Accessories:

    a. Support Bracket Types: As indicated on Drawings.
    b. Individual Masonry Support Bracket Types: As indicated on Drawings.

2. Assembly provides steel components for adjustable support of brickwork above horizontal masonry joints and openings.

3. System attached to substrate by one of the following:

    a. Cast-in channel anchors for attachment of adjustable brickwork supports:

        1) Embedded Channel Type: Type HTA.
        2) T-head adjusting bolts
        3) Washers.
        4) Locking nuts.

    b. Special Brackets and Applications:

        1) Grouted-in-Wall Anchors: Type KM.
        2) Parapet Support Brackets: Type HAV.
        3) Support Brackets Facing Brick around Columns:

2.3 FABRICATION

A. Shop assemble items for delivery to site in variety of sizes required. Provide complete assembly.

B. Mechanical Fastenings: Bolts, nuts, and washers consistent with design of components.

2.4 FINISHES

A. Unprotected Steel: Clean surfaces of rust, scale, grease, and foreign matter before finish or galvanizing.

B. Structural Carbon Steel Components: Hot-dip galvanized after fabrication, ASTM A123.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and supports to receive adjustable brickwork support system.

B. Verify dimensions, tolerances, and method of attachment with other work.

C. Notify Architect of conditions that would adversely affect installation.

D. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

A. Supply items required to be attached to substrate with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install adjustable brickwork support system in accordance with manufacturer's instructions at locations indicated on the Drawings.

B. Install items plumb and level, accurately fitted, free from distortion or defects.

C. Adjust components to suit site conditions.

D. Obtain approval from Architect and manufacturer before site cutting or making adjustments not scheduled.

3.4 TOLERANCES

A. Maximum Variation from Plumb: 1/8 inch.

3.5 PROTECTION

A. Protect installed adjustable brickwork support system from damage during construction.

B. Touch-up damage to factory-applied finishes using appropriate materials and techniques.

END OF SECTION 040524

SECTION 042000 - UNIT MASONRY

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 masonry units.
2. Lintels.
3. Brick.
4. Mortar and grout materials.
5. Reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Accessories.
9. Mortar and grout mixes.

B. Products Installed but not Furnished under This Section:

1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.
3. Cavity wall insulation adhered to masonry backup.

C. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 019115 "Building Enclosure Commissioning."
3. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
4. Section 072100 "Thermal Insulation" for cavity wall insulation.
5. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Discussion topics shall include;

    a. Schedule.
    b. Sequence.
    c. Coordination of trades.
    d. Substrate review and acceptance.
    e. Protection
    f. Shop drawings and submittals.
    g. Interface condition and details.
    h. Environmental constraints.
    i. Mockups.
    j. Testing requirements.
    k. Field quality control efforts.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Project specific. For the following:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R. Indicate elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
4. Coordinate with air/vapor barrier shop drawings, clearly showing flashings, penetrations, locations of control and expansion joints on all building elevations. Include integration with adjacent materials and membranes.

C. Samples for Verification: For each type and color of the following, provide one each:

1. Clay face brick, in the form of straps of five or more bricks.
2. Special brick shapes.
3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
4. Weep/cavity vents.
5. Cavity drainage material.
6. Accessories embedded in masonry.

D. Delegated Design Submittals: For masonry anchors and ties, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

1.6 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers,

source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Material Certificates: For each type of the following:

1. Masonry units.

a. Include data on material properties and test reports for absorption.
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.

2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

C. Qualification Statements: For testing agency.

D. Delegated design engineer qualifications.

E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

F. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602.

G. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

H. Manufacturer's Certificates:

1. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Installers: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.
3. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.8 MOCKUPS

A. Wall Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for installation. See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.

1. Build mockups for each type of exposed unit masonry construction typical exterior wall in sizes approximately 96 inches (2438 mm) long by 48 inches (1219 mm) high by full thickness, including face and backup wythes and accessories.

    a. Include a joint with sealant and joint backer (to avoid three-sided sealant adhesion) at least 16 inches (406 mm) long in each mockup.
    b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (305 mm) wide by 16 inches (406 mm) high.
    c. Include through-wall flashing installed for a 24-inch (610-mm) length in corner of exterior wall mockup approximately 16 inches (406 mm) down from top of mockup, with a 12-inch (305-mm) length of flashing left exposed to view (omit masonry above half of flashing). Include end dams.
    d. Include metal studs, sheathing, sheathing joint-and-penetration treatment, air barrier, veneer anchors, flashing, end dams, cavity drainage material, and mesh weep/vents, and any other accessory that will be used to construct the wall in exterior masonry-veneer wall mockup.

2. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship and also to confirm whether the components are properly installed per the design intent and recognized industry standards to remain air and watertight.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations by Change Order.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
7. Refer to Section 019117 “Building Enclosure Functional Performance Testing” for mockup testing requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units 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. If units become wet, do not install until they are dry.

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.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (610 mm) down both sides of walls, and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (610 mm) down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain exposed masonry units cementitious mortar components and mortar aggregate from single source producer or manufacturer.

B. For exposed masonry units and cementitious mortar components *within each specified color range*, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design masonry anchors and ties.

B. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where indicated, provide units that comply with requirements for fire-resistive ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS (CMU-1)

A. Regional Materials: Verify CMUs are manufactured within 100 miles (160 km) of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners unless otherwise indicated.

C. CMUs: ASTM C90, normal weight unless otherwise indicated.

1. Unit Compressive Strength: As indicated on Drawings.
2. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.

2.5 LINTELS

A. Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength of not less than that of CMUs.

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 BRICK (FBR-1A/B, FBR-2, FBR-3)

~~*A. Indigenous Materials: Verify brick is manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If transporting materials by rail or water, multiply the distance transported by rail or water by 0.25 to determine the distance to Project site.*~~

~~*B. Regional Materials: Verify brick is manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.*~~

C. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels and where shapes produced by sawing would result in sawed surfaces being exposed to view, including but not limited to, 24-inch long units to be used in areas where exposed brick would be less than a quarter of length of typical brick unit. Provide special shapes as required for Adjustable Concealed Lintel System and Adjustable Brick Support System.

D. Clay Face Brick: Facing brick complying with ASTM C216, Grade SW, Type FBX.

1. Basis-of-Design Manufacturer: Subject to compliance with all specified requirements including, but not limited to, brick color, texture, and size/profile, provide Basis-of-Design as noted below, or from list of Acceptable Manufacturers;

a. Interstate Brick.
b. Belden Brick Company (The).
c. Glen-Gery Corporation.
d. Summit Brick Company.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 6200 psi and Maximum Saturation Coefficient of 0.78.
3. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested in accordance with ASTM C67/C67M.
4. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
5. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 15-5/8 inches (397 mm) long.
6. Application: Use where brick is exposed unless otherwise indicated.
7. Color and Texture:

a. FBR-1A: *Basis-of-Design: Interstate Brick*: Beige; Smooth; Matte Finish; Color: Custom 2-Part blend of Artic White (67%) and Ash (33%). Mortar color: Prism Pigments; P2610 Camel.
b. FBR-1B: *Basis-of-Design: Interstate Brick*: Beige; Textured; Scratch Finish; Color: Custom 2-Part blend of Artic White (67%) and Ash (33%) to match FBR-1A. Mortar color: Prism Pigments; P2610 Camel.
c. FBR-2: Terracotta; Basis-of-Design: Belden Brick Company: Velour Finish; Color: Regal Blend. Mortar color: Prism Pigments; P4640 Rootbeer.
d. FBR-3: Dark Terracotta; Basis-of-Design: Belden Brick Company: Velour Finish; Mix of 50% Bismark Dark and 50% Regal Blend (Pre-Sorted to remove the lightest color in this range). Mortar color: Prism Pigments; P4640 Rootbeer.

2.7 MORTAR AND GROUT MATERIALS

A. Regional Materials: Manufacture aggregate for mortar and grout within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

B. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

C. Hydrated Lime: ASTM C207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Prism Corporation; Prism Pigments.

F. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6.4 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
5. Aggregate shall contain no more than 50 parts per million of chloride ions and shall be free of organic contaminants.

G. Aggregate for Grout: ASTM C404. Aggregate shall contain no more than 50 parts per million of chloride ions and shall be free of organic contaminants.

H. Cold-Weather Admixture: Not allowed. Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

I. Water: Potable.

2.8 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Heckmann Building Products, Inc.; No. 376 Rebar Positioner.
b. Hohmann & Barnard, Inc; #RB or #RB-Twin Rebar Positioner.
c. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Exterior Walls: Stainless steel.
3. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
5. Wire Size for Veneer Ties: 0.148-inch (3.77-mm) diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (406 mm) o.c.
7. Provide in lengths of not less than 10 ft. (3 m), with prefabricated corner and tee units.

D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder or truss type with single pair of side rods.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hohmann & Barnard, Inc.
b. Wire-Bond.

2.9 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Stainless Steel Wire: ASTM A580/A580M, Type 304.
2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

C. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (10-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from stainless steel.

D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

E. Adjustable Masonry-Veneer Anchors (FBRA-1/2):

1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf (445 N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.6 mm).
2. Fabricate wire ties from 0.187-inch- (4.76-mm-) diameter, stainless steel wire unless otherwise indicated.
3. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with thermally resistant wingnut head designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation with factory-installed gasketed washer to seal at face of insulation and sheathing and a coating to reduce thermal conductivity. Use in conjunction with Thermal-Grip brick-tie washers. Use Concrete/CMU Screw where backup in Cast-in-Place Concrete or CMU.

a. Basis-of-Design Product: Subject to compliance with requirements, provide Heckmann Building Products, Inc.; Pos-I-Tie with ThermalClip or a comparable product by one of the following:

1) Hohmann & Barnard, Inc.; 2-Seal Thermal Wing Nut Anchor.

4. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83 mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300 Series stainless steel shank.

2.10 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch (0.40 mm) thick.
2. Fabricate continuous flashings in sections 96 inches (2438 mm) long minimum, but not exceeding 12 ft. (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
4. Fabricate through-wall flashing with drip edge (TWF-2) unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
5. Fabricate metal drip edges (TWF-2) and end dams from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed. Provide Lipped Brick Profile where indicated on Drawings.
6. Fabricate metal expansion-joint strips and end dams from stainless steel to shapes indicated.
7. Solder metal items at corners. Fabricate fully soldered end dams.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Stainless Steel Fabric Flashing (FLXF-1): Composite, flashing product consisting of 2 mil (0.05 mm) of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with an adhesive. Flashing to be compatible with fluid applied, vapor-retarding membrane air barrier. Verify in writing from the Manufacturer.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Hohmann & Barnard, Inc; Mighty-Flash.
2) York Manufacturing, Inc; Multi-Flash SS 304.

b. Flashing materials must be able to withstand 300º F temperature without changing the long-term performance of the flashing.

C. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates. Provide products that are compatible with air barrier membrane.

E. Termination Bars for Flexible Flashing (TWF-1): Stainless steel bars 1/8 inch by 1 inch (3.2 mm by 25 mm).

2.11 ACCESSORIES

A. Compressible Filler (MA-2): Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets (MA-1): Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips (MA-3): Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vents: Use the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent (WPS-1): One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Advanced Building Products Inc.; Mortar Maze Weep Vent.
2) Heckmann Building Products, Inc.; No. 85 Cell Vent.
3) Hohmann & Barnard, Inc; QV Quadro-Vent.
4) Mortar Net Solutions.
5) Wire-Bond; Cell Vent (#3601).

E. Cavity Drainage Material (WPS-2): Free-draining mesh, made from polymer strands that will not degrade within the wall cavity. Cavity drainage material should completely fill the full width of the air space.

1. Mortar Deflector: Strips, full depth of cavity and 10 inches (254 mm) high, with dovetail-shaped notches that prevent clogging with mortar droppings.

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mortar Net Solutions; Mortar Net with Insect Barrier or a comparable product by one of the following:

1) Advanced Building Products Inc.
2) Hohmann & Barnard, Inc.
3) Masonry Accessories, Inc.
4) Wire-Bond.

F. Proprietary Acidic Masonry Cleaner: The use of hydrochloric acids and cleaners containing salts that form hydrochloric acid in solution is prohibited. Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.

b. EaCo Chem, Inc.
c. PROSOCO, Inc.

2.12 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement and lime.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type S.

D. Pigmented Mortar: Use colored cement product.

1. Pigments do not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.
3. Application: Use pigmented mortar for exposed mortar joints as indicated.

E. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (13 mm) or minus 1/4 inch (6.4 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (13 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6.4 mm) in a story height or 1/2 inch (13 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), or 1/2-inch (13-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft. (3.2 mm in 3 m), 1/4 inch in 20 ft. (6.4 mm in 6 m), or 1/2-inch (13-mm) maximum.

3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), 3/8 inch in 20 ft. (10 mm in 6 m), or 1/2-inch (13-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft. (3.2 mm in 3 m), 1/4 inch in 20 ft. (6.4 mm in 6 m), or 1/2-inch (13-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), 3/8 inch in 20 ft. (10 mm in 6 m), or 1/2-inch (13-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft. (6.4 mm in 3 m), or 1/2-inch (13-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.6 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3.2 mm), with a maximum thickness limited to 1/2 inch (13 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3.2 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (10 mm) or minus 1/4 inch (6.4 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3.2 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3.2 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.6 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern indicated on Drawings; do not use units with less-than-nominal 4-inch (102-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (102 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (102-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (610 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Anchor top of partitions as noted on contract documents providing a “soft joint”.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs and hollow brick as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.
4. Rake out mortar joints for pointing with sealant.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

F. Cut joints flush where indicated to receive waterproofing cavity wall insulation and air barriers unless otherwise indicated.

3.6 ANCHORED MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener. Anchor penetrations through the air/vapor barrier must be sealed with compatible sealant unless pre-construction mock-up testing does not dictate this requirement.
2. Embed tie sections in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 18 inches (457 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally, with not less than one anchor for each 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 8 inches (203 mm), around perimeter.

B. Provide airspace between back of masonry veneer and face of insulation. Refer to Exterior Wall Types on Drawings for airspace depth.

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.
2. Cavity Protection: Provide means and methods to prevent bridging of cavity with mortar. Use "clean out" board or other means to keep cavity clean of mortar and mortar droppings. Strike off back of face veneer to remove excess, extruded mortar.

3.7 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (152 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement. Provide a maximum control joint spacing per ACI 530/NCMA TEK-Notes. Control and expansion joints are to meet NCMA and BIA standards.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build in compressible joint fillers where indicated.
2. Locate expansion joints as indicated on Drawings. Space no more than 25 feet on center.

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch (10 mm).

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.9 LINTELS

A. Install steel lintels where indicated. Provide steel hot-dipped galvanized lintels per the construction documents.

B. Provide concrete or masonry lintels where indicated and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are indicated without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches (203 mm) at each jamb unless otherwise indicated.

3.10 FLASHING AND CAVITY VENTS

A. General: Install embedded flashing and weep vents in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing a minimum of 6 inches above the top of the cavity drainage material; upper termination of flashing to be integrated with the AWB such that a continuous air and water control layer is provided. Fasten upper edge of flexible flashing to sheathing through termination bar. Provide a termination bead of sealant. Confirm compatibility of materials.

3. At lintels and shelf angles, extend flashing 6 inches (152 mm) minimum, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches (152 mm) minimum, to edge of next full unit and turn ends up not less than 2 inches (51 mm) to form end dams.
4. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge. Set drip edge in a bead of sealant.

C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.

D. Install weep vents in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use specified weep/cavity vent products to form weep holes.
2. Space weep vents 24 inches (610 mm) o.c. unless otherwise indicated and at end dam locations.

E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

F. Install cavity vents in head joints in exterior wythes at 24 inches O.C. unless otherwise indicated. Use specified weep/cavity vent products to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep vents above horizontal blocking.

3.11 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height. Consolidate grout with mechanical vibrator.
2. Limit height of vertical grout pours to not more than 60 inches (1524 mm).

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Inspections: Special inspections in accordance with Level 3 in TMS 402.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

H. Grout Test (Compressive Strength) and Slump Test: For each mix provided, in accordance with ASTM C1019.

I. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at 7 days and at 28 days.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry within 24 to 48 hours and as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
6. Clean masonry with a masonry cleaner applied according to manufacturer's written instructions.

3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches (102 mm) in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches (457 mm) of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 044200 - EXTERIOR STONE CLADDING

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. Stone panels set with individual anchors.
2. Stone panels mechanically anchored on steel stud frames.

B. Related Requirements:

1. Section 042000 "Unit Masonry".
2. Section 054000 "Cold-Formed Metal Framing" for steel stud frames supporting stone cladding.
3. Section 079200 "Joint Sealants" for sealing joints in stone cladding system with elastomeric sealants.

1.3 DEFINITIONS

A. Definitions contained in ASTM C 119 apply to this Section.

B. IBC: International Building Code.

C. Stone Cladding Assembly: An exterior wall covering system consisting of stone panels together with anchors, backup structure, fasteners, and sealants used to secure the stone to the building structure and to produce a weather-resistant covering.

1. Backup structure includes steel stud frames, miscellaneous steel framing required to secure stone to the building structure, concrete and CMU. Refer to Drawings for Exterior Wall Types.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Environmental Product Declaration (EPD): For each product.

C. Shop Drawings: Show project specific fabrication and installation details for stone cladding assembly, including dimensions and profiles of stone units.

1. Show locations and details of joints both within stone cladding assembly and between stone cladding assembly and other construction.
2. Include details of sealant joints.
3. Show locations and details of anchors and backup structure.
4. Show direction of veining, grain, or other directional pattern.
5. Coordinate with air/vapor barrier shop drawings, clearly showing flashings, penetrations, locations of control and expansion joints on all building elevations. Include integration with adjacent materials and membranes.

D. Samples for Initial Selection: For joint materials involving color selection.

E. Stone Samples for Verification: Sets for each variety, color, and finish of stone required; not less than 12 inches (300 mm) square.

1. Sets shall consist of at least five Samples, exhibiting extremes of the full range of color and other visual characteristics expected and will establish the standard by which stone will be judged.

F. Sealant Samples for Verification: For each type and color of joint sealant required.

G. Delegated-Design Submittal: For stone cladding assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, professional engineer and testing agency.

B. Welding certificates.

C. Material Test Reports:

1. Stone Test Reports: For stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three years.
2. For metal components, by a qualified testing agency, indicating chemical and physical properties of metal.
3. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer complying with requirements in Section 079200 "Joint Sealants" and indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

D. Preconstruction test reports.

E. Source quality-control reports.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather and hot-weather requirements.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop with at least 10 years experience that employs skilled workers who custom fabricate stone cladding assemblies similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: A firm or individual experienced with at least 10 years experience in installing stone cladding assemblies similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.

C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel and AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical exterior wall area not less than 72 inches (1800 mm) long by 48 inches (1200 mm) high.

    a. Include typical components, attachments to building structure, integration with adjacent assemblies and methods of installation. Photograph mockup before concealing portions or provide stepped mockup to allow review of each condition.
    b. Include sealant-filled joint complying with requirements in Section 079200 "Joint Sealants."
    c. Include an area that has been damaged and repaired.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing and propensity to stain stone according to sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

B. Preconstruction Field Testing of Sealants: Before installing joint sealants, field test their adhesion to joint substrates according to Section 079200 "Joint Sealants."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation. Do not use chemically treated wood or wood containing tannin or other substances that may stain the stone.

B. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.

C. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

E. Store aggregates in locations where grading and other required characteristics can be maintained and where contamination can be avoided.

1.10 FIELD CONDITIONS

A. Protect stone cladding during erection by doing the following:

1. Cover tops of stone cladding installation with nonstaining, waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24 inches (600 mm) down both sides and hold securely in place.
2. Prevent staining of stone from sealants, and other sources. Immediately remove such materials without damaging stone.
3. Protect base of walls from rain-splashed mud splatter by coverings spread on ground and over wall surface.
4. Protect sills, ledges, and projections from sealant droppings.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace stone cladding damaged by frost or freezing conditions. Comply with cold-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.

C. Hot-Weather Requirements: Comply with hot-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.

D. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 40 deg F (5 deg C) or when joint substrates are wet.

1.11 COORDINATION

A. Coordinate installation of inserts that are to be embedded in concrete or masonry, flashing reglets, and similar items to be used by stone cladding Installer for anchoring, supporting, and

flashing of stone cladding assembly. Furnish setting drawings, templates, and directions for installing such items and deliver to Project site in time for installation.

B. Time delivery and installation of stone cladding to avoid extended on-site storage and to coordinate with work adjacent to stone cladding.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Stone: Obtain stone, regardless of finish, from single quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.
2. Make quarried blocks available for examination by Architect.

B. Source Limitations for Other Materials: Obtain each type of stone accessory, sealant, and other material from single manufacturer for each product.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stone cladding assembly.

B. General: Design stone anchors and anchoring systems according to ASTM C 1242.

1. Stone anchors shall withstand not less than two times the weight of the stone cladding in both compression and tension.

C. Structural Performance: Stone cladding assembly shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Wind Loads: As indicated.
2. Equipment Loads: Allow for loads due to window cleaning and maintenance equipment.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Shrinkage and Creep: Allow for progressive vertical shortening of building frame equal to 1/8-inch in 10 feet (3 m).

F. Safety Factors for Stone: Design stone cladding assembly to withstand loads indicated without exceeding stone's allowable working stress determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:

1. Safety Factor for Granite: 3.

2. Safety Factor for Stone: 6.

G. Design stone anchors and backup structure to withstand loads indicated without exceeding allowable working stresses established by the following:

1. For Structural Steel: AISC 360.
2. For Cold-Formed Steel: AISI's "North American Specification and Commentary for the Design of Cold-Formed Steel Structural Members."
3. For Cold-Formed Stainless Steel: ASCE/SEI 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."
4. For Cast-in-Place and Postinstalled Fasteners in Concrete: One-fourth of tested capacity when installed in concrete with compressive strength indicated.
5. For Postinstalled Fasteners in Masonry: One-sixth of tested capacity when installed in masonry units indicated.

H. Limit deflection in each prefabricated assembly caused by indicated loads and thermal movements, acting singly or in combination with one another, to not more than 1/720 of assembly's clear span or the following, whichever is smaller:

1. 1/16 inch (1.5 mm), measured in plane of wall.
2. 1/4 inch (6 mm), measured perpendicular to wall.

I. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances of building's structural system. Concrete fabrication and erection tolerances are specified in Section 033000 "Cast-in-Place Concrete."

J. Provision for Deflection of Building Structure:

1. Deflection Due to Weight of Stone Cladding Assembly: Allow for L/600 of structural members supporting stone cladding assembly.
2. Live Load Deflection: Allow for L/600 of structural members supporting stone cladding assembly, due to live loads imposed on building's structural frame after stone installation.

K. Corrosion and Staining Control: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Materials shall not stain exposed surfaces of stone and joint materials.

L. Season stone to extent that excess water does not damage stone during freezing temperatures and to ensure color change does not occur.

2.3 GRANITE (STN-2)

A. Material Standard: Comply with ASTM C 615/C 615M.

B. Regional Materials: Stone shall be fabricated within 100 miles of Project site from materials that have been extracted, harvested, or recovered within 100 miles of Project site.

C. Varieties and Sources: Subject to compliance with requirements, provide the following:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Coldspring USA; Mesabi Black Granite or approved equal.

D. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

E. Finish: Diamond 10 finish.

F. Thickness: As indicated on Drawings.

2.4 SANDSTONE (STN-1)

A. Material Standard: Comply with ASTM C 616/C 616M, Classification II Quartzitic Sandstone.

B. Regional Materials: Stone shall be fabricated within 100 miles of Project site from materials that

C. have been extracted, harvested, or recovered within 100 miles of Project site.

D. Varieties and Sources: Subject to compliance with requirements, provide the following:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Russell Stone Products; Bloom Run Sandstone or approved equal.

E. Finish: Saw cut, smooth finish.

F. Thickness: As indicated on Drawings.

2.5 FRAMING FOR BACKUP STRUCTURE

A. Steel Stud Frames: Galvanized-steel wall framing complying with Section 054000 "Cold-Formed Metal Framing."

2.6 ANCHORS AND FASTENERS

A. Fabricate anchors from stainless steel, ASTM A 240/A 240M or ASTM A 666, Type 316; temper as required to support loads imposed without exceeding allowable design stresses. Fabricate dowels and pins for anchors from stainless steel, ASTM A 276, Type 316.

B. Adjustable, Screw-Attached Veneer Anchors (STNA-1): Units consisting of a wire tie section and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to metal studs, and as follows:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Heckmann Building Products, Inc.; Pos-I-Tie KeyBolt with KeyBolt Slot

2. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
3. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive wire tie and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
4. Stone anchor: Stainless steel split-bend stone anchor.

2.7 STONE ACCESSORIES

A. Setting Shims: Strips of resilient plastic or vulcanized neoprene, Type A Shore durometer hardness of 50 to 70, nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

B. Setting Buttons: Resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of pointing materials.

C. Concealed Sheet Metal Flashing: Fabricated from stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick, and complying with Section 076200 "Sheet Metal Flashing and Trim."

D. Cellular Plastic Weep/Vents: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, of length required to extend from exterior face of stone to cavity behind, in color selected from manufacturer's standard.

E. Sealants for Joints in Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Section 079200 "Joint Sealants" and do not stain stone:

1. Joint Sealant: Silicone, nonstaining, S, NS, 100/50, NT.
2. Joint-Sealant Colors: Match color of stone.

F. Sealant for Filling Kerfs: Same sealant used for joints in stone cladding.

2.8 STONE FABRICATION

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.

1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
2. For stone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Control depth of stone and back check to maintain minimum clearance of 1-1/2 inches (38 mm) between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.

C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.

D. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.

E. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.

F. Quirk-miter corners unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

G. Cut stone to produce uniform joints 3/8 inch (10 mm) wide and in locations indicated.

H. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.

I. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

1. Produce moldings and molded edges with machines that use abrasive shaping wheels made to reverse contour of molding shape.

J. Clean backs of stone to remove rust stains, iron particles, and stone dust.

K. Inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

2.9 FABRICATION OF BACKUP STRUCTURE

A. Fabrication of Steel Stud Frames: Fabricate and assemble by welding to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform source quality-control testing.

1. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
2. Furnish test specimens randomly selected from same blocks as actual materials proposed for incorporation into the Work.
3. Flexural Strength Tests: ASTM C 880/C 880M, performed on specimens of same thickness, orientation of cut, and finish as installed stone. One set of test specimens is required to be tested for every 3000 sq. ft. (300 sq. m), but not fewer than two sets for each stone variety.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive stone cladding and conditions under which stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone cladding.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone cladding.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLING BACKUP STRUCTURE

A. Installing Steel Stud Frames: Install to comply with requirements in Section 054000 "Cold-Formed Metal Framing."

1. Install steel stud frames level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.5 mm) and no variation in position exceeding 1/8 inch (3 mm).
2. Clean welds, bolted connections, and abraded areas immediately after erection. Repair galvanizing to comply with ASTM A 780/A 780M.

3.3 SETTING STONE CLADDING, GENERAL

A. Before setting stone, clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Execute stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.

1. Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.

C. Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.

D. Set stone to comply with requirements indicated (running bond ashlar pattern as indicated on Drawings). Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated, with uniform joints of widths indicated, and with edges and faces aligned according to established relationships and indicated tolerances. Anchor penetrations through the air/vapor barrier must be sealed with compatible sealant unless pre-construction mock-up testing does not dictate this requirement.

E. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.

1. Sealing expansion and other joints is specified in Section 079200 "Joint Sealants."
2. Keep expansion joints free.

F. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water, to divert water to building exterior. Extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams. At top of flashing install termination bar to reglet to the back-up to terminate the flashing.

G. Keep cavities open where unfilled space is indicated between back of stone units and backup wall.

1. Place weep holes in joints where moisture may accumulate, including at base of cavity walls and above shelf angles and flashing. Locate weep holes at intervals not exceeding 24 inches (600 mm). Use cellular plastic weep/vents.

3.4 JOINT-SEALANT INSTALLATION

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.5 INSTALLATION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (12 mm in 12 m) or more. For external corners, corners and jambs within 20 feet (6 m) of an entrance, expansion joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch in 40 feet (10 mm in 12 m) or more.

B. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch (10 mm) maximum.

C. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.

D. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/4 inch (6 mm).

E. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less. For joints within 60 inches (1500 mm) of each other, do not vary more than 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less from one to the other.

F. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/16-inch (1.5-mm) difference between planes of adjacent units.

3.6 ADJUSTING AND CLEANING

A. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and stone cladding that does not match approved samples and mockups. Damaged stone may be repaired if Architect approves methods and results.

B. Replace damaged or defective work in a manner that results in stone cladding's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone cladding as work progresses. Remove excess sealant and smears as sealant is installed.

D. Final Cleaning: Clean stone cladding no fewer than six days after completion of pointing and sealing, using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone. Clean stone to comply with stone supplier’s written instructions.

END OF SECTION 044200

SECTION 044310 – SITE STONE MASONRY

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. Stone veneer and coping adhered to concrete retaining wall backup.

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 03 Section 'Miscellaneous Site Concrete’
   3. Division 07 Section ‘Joint Sealants’
   4. Division 32 Section ‘Crushed Stone Paving’
   5. Division 32 Section 'Unit Paving’
   6. Division 32 Section 'Metal Edging’
   7. Division 32 Section ‘Exterior Planting’

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For stone varieties proposed for use on the Project, include test data indicating compliance with physical properties required by referenced ASTM standards.

B. Samples for Initial Selection: For colored mortar and other items involving color selection.

C. Samples for Verification:
   1. For each stone type indicated. Include at least four (4) samples in each set for each type of stone, exhibiting extremes of the full range of color and other visual characteristics expected in completed Work. Samples will establish the standard by which stone provided will be judged.
   2. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.

D. Shop drawings: Submit for fabrication and installation. Show sizes, thicknesses, jointing, anchoring, connection details, support, and dimensions for each stone piece. Show in detail the construction, method of installation and attachment, and anchoring devices. Drawings shall clearly show the relationship to adjoining construction. Stone pieces on the shop drawings shall be numbered and the numbers shall correspond to the numbers of stone pieces delivered to the site. Do not fabricate any pieces until shop drawings have been reviewed by the Landscape Architect. Show location of mortar pointed and soft caulked joints.
   1. Provide shop drawings for the following:
      a. Stone veneer and coping for walls

1.4 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, sources of supply, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Landscape Architect and approved in writing.

B. Qualification Data: For qualified Installer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs experienced stonemasons and stone fitters.

B. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Color Selection: Color selection shall be made from the full range of available pigmentation. From that range, five (5) colors will be selected for use in the mockups.

E. Mockups: Build mockups 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.

F. Pre-Installation Meeting: Before beginning masonry work, schedule and conduct a meeting at Project site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Contractor, the installer, the installer’s field foreman and manufacturer’s representative. Inform the Landscape Architect five (5) business days in advance of the scheduled meeting time.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery & Handling: Properly crate and band stone units for shipment and receiving at job site. Handle each stone material type to prevent chipping, marking, breakage, soiling, or other damage both during delivery and during storage at site.

B. Storage & Protection: Store stone units on non-staining wood skids or pallets set not less than 4 inches above ground, covered with non-staining, waterproof membrane. Place and stack skids and pavers to distribute weight evenly and to prevent breakage or cracking of pavers. If units are not stored in an enclosed location, protect stored stone units from weather with waterproof cover to prevent staining or contamination, but allow air to circulate around units.

C. Packaged Materials: Deliver packaged materials in clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged

materials apply to bulk shipments. Protect materials from deterioration by moisture and temperature during delivery and during storage at site. Protect liquid components from freezing.

D. Deliver pre blended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store pre blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

F. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

G. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.

B. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.

C. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

D. Protection of Stone Masonry: During construction, cover stairs, benches and all other masonry work with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

E. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the surface of stone masonry.
   1. Protect base of walls and all other masonry work from rain-splashed mud and mortar splatter by coverings spread on the ground and over the bench and wall surface.
   2. Protect walls and all other masonry work from mortar droppings.

F. Work Protection Requirements: Provide weather protection during entire time of placement of masonry system. Maintain protection over entire area storage and work area to maintain specified moisture levels, prevent wind or rain disturbance of setting materials, protect from run-off from adjacent areas, and generally maintain optimum installation conditions. Contractor is responsible for means and methods for such protection, including physical cover, work sequencing and scheduling and other means of protection, as Contractor deems appropriate.

G. Weather/Temperature: (Cold Weather Requirements) Do not commence work when a descending air temperature in the shade away from artificial heat reaches 40˚ F, and do not

resume until an ascending air temperature in the shade and away from artificial heat reaches 35˚ F.

1. Verify all Environmental Requirements with manufacturer prior to commencing work.
2. Do not undertake work on frozen substrate or using frozen materials or materials mixed with or coated with ice or frost.
3. Protect work from frost and remove and replace any work damaged by frost or freezing.
4. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
5. Do not build on frozen sub-grade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
6. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

H. Weather/Temperature: (Hot Weather Requirements) Protect masonry work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required.

1. Verify all Environmental Requirements with manufacturer prior to commencing work.
2. Do not apply mortar to substrates with temperatures of 100˚ F and above.
3. Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

I. Utilization Restrictions

1. Plywood panels must be kept on areas which will be subject to continued movement of materials and equipment.

J. Maintenance of Traffic, Access and Utilities: In accordance with Division 01.

1.8 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.9 SEQUENCING AND SCHEDULING

A. Advise installers of other work about specific requirements for placement of reinforcement, veneer anchors, and similar items to be built into stone masonry.

B. Coordinate Work of this Section with Work of all other Sections of Specification.

1.10 CLOSEOUT REQUIREMENTS

A. Project Record Documents: Submit in accordance with Division 01 Section “Closeout Procedures”.

B. Final Cleaning: In accordance with Division 01 Section “Execution Requirements”.
   1. Leave site in an orderly, “broom clean” condition.

C. Operations and Maintenance Data, Warranties:
   1. Provide Maintenance and cleaning instructions for Owner.
   2. Provide to Owner all product warranties provided by manufacturers.

PART 2 - PRODUCTS

2.1 STONE CLAD SEAT WALL – AT BUILDING ENTRY

A. Granite
   1. Products: Subject to compliance with requirements, provide the following:
      a. Mesabi Black Granite as provided by Coldspring USA, 17482 Granite West Road, Cold Spring, MN 56320; Website: https://www.coldspringusa.com/

B. Description: Uniform, Stone, at a minimum, the following physical requirements:

1.	Compressive Strength per (ASTM C 170)	18,680 psi, min.
2.	Flexural Strength per (ASTM C 880)	1200 psi, min.
3.	Modulus of Rupture per (ASTM C 99)	1,552 psi, min.
4.	Absorption per (ASTM C97)	0.05 %, max..
5.	Density (ASTM C503):	175.5 lb/cubic foot, min.
6.	Abrasion (ASTM C241):	25 Ha, min.

   7. Sizes as indicated on the Drawings.
      a. Dimensional Tolerances: Plus or minus 1/16 inch.
      b. Thickness: as indicated on the Drawings.
      c. Joint width shall be 1/4 inch.
   8. Finish:
      a. Finish for unexposed surfaces shall be sawn.
      b. Finish for exposed surfaces:
         1) Veneer: Diamond 100
         2) Cap: Diamond 8

C. Match Landscape Architect’s samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.2 STONE CLAD SEAT WALL – AT ENTRY GARDEN

A. Limestone: Comply with ASTM C 568.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Kentucky River Marble Limestone caps and Kentucky Limestone veneer to match the finishes, patterns, textures, and colors of existing campus seat walls.

B. Description: Uniform, Stone, at a minimum, the following physical requirements:
   1. Sizes as indicated on the Drawings.
      a. Dimensional Tolerances: Plus or minus 1/16 inch.

b. Thickness: as indicated on the Drawings.
c. Joint width shall be 1/4 inch.

2. Finish:
a. Finish for unexposed surfaces shall be sawn.
b. Finish for exposed surfaces:
1) Veneer: To match existing site walls on campus
2) Cap: To match existing site walls on campus

2.3 STONE CLAD RETAINING WALL – AT RAD MED GARDEN

A. Limestone: Comply with ASTM C 568.
1. Products: Subject to compliance with requirements, provide the following:
a. Bloom Run Stone as provided by Russell Stone Products, 2640 Greenville Pike, Grampian, PA 16838

B. Description: Uniform, Stone, at a minimum, the following physical requirements:

1.	Compressive Strength per (ASTM C 170)	18,438 psi, min.
2.	Modulus of Rupture per (ASTM C 99)	1,399 psi, min.
3.	Absorption per (ASTM C97)	1.23%, max..
4.	Density (ASTM C503):	153.94 lb/cubic foot, min.

5. Sizes as indicated on the Drawings.
a. Dimensional Tolerances: Plus or minus 1/16 inch.
b. Thickness: as indicated on the Drawings.
c. Joint width shall be 1/4 inch.
6. Finish:
a. Finish for unexposed surfaces shall be sawn.
b. Finish for exposed surfaces:
1) Veneer: Split-Face
2) Cap: Split-Face

2.4 MORTAR MATERIALS

A. Portland Cement: ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide white cement as required to produce mortar color indicated. Mortar shall have added color selected by the Landscape Architect.
1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of Portland cement complying with ASTM C150, Type I or III, and hydrated lime complying with ASTM C207.
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. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
b. Lafarge Holcim; Eaglebond.
c. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
d. Approved Equal

D. Mortar Cement: complying with ASTM C1329
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. Lafarge Holcim; Lafarge Mortar Cement
b. Approved Equal

E. Masonry Cement: complying with ASTM C 91.
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. Holcim (US) Inc.; White Mortamix Masonry Cement.
b. Lafarge Holcim; Trinity Super White Masonry Type S or Trinity White Masonry Type N.
c. Lehigh Cement Company; Lehigh White Masonry Cement.
d. Approved Equal.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in stone masonry mortar.
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. Davis Colors; True Tone Mortar Colors.
b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
c. Solomon Colors; SGS Mortar Colors.
d. Approved Equal.

G. Aggregate: ASTM C144 and as follows:
1. For joints narrower than ¼" use aggregate graded with 100% passing the No. 8 sieve and 95% the No. 16 sieve.
2. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
a. White Aggregates: Natural white sand or ground white stone.
b. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
c. All color selections to be reviewed & approved by the Landscape Architect.

H. Water: Potable.

2.5 MISCELLANEOUS MASONRY ACCESSORIES & MATERIALS

A. Adjustable, Screw-Attached Veneer Anchors:
1. Product: Heckman Building Products, Inc.; Pos-I-Tie KeyBolt with KeyBolt Slot, specified as part of Division 04 Section 'Exterior Stone Cladding'.

B. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

C. Dowels: Fabricate anchors from stainless steel, ASTM A240/A 240M, Type 316. Fabricate dowels from stainless steel, ASTM A276, Type 316.
1. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8-inch cover on outside face.

D. Epoxy for setting dowels: Two component epoxy or modified acrylic adhesive, specifically recommended by manufacturer or stone supplier for setting dowels in stone.
1. Product: Sikadur Anchoring Adhesives, as manufactured by Sika Corporation, 201 Polito Ave, Lyndhurst, NJ 07071, or Approved Equal.

2.6 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.
   1. 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:
      a. Diedrich Technologies, Inc.
      b. Dominion Restoration Products.
      c. EaCo Chem, Inc.
      d. Approved Equal

2.7 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride.
   2. Limit cementitious materials in mortar to Portland cement and lime.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not re-temper or use partially hardened material.

B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Stone Masonry: Comply with ASTM C270 Specification.
   1. Mortar for Setting Stone: Type N.
   2. Mortar for Pointing Stone: Type N or Type O.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine new and existing surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Starting on the work shall imply acceptance of the surfaces and conditions to perform the work specified.

B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, and other items installed in substrates and required for or extending into stone masonry are correctly installed.

C. Verify by measurements taken at the job site those dimensions affecting the work. Bring field dimensions which are at variance with those on the reviewed shop drawings to the attention of the Landscape Architect. Obtain decision regarding corrective measures before the start of fabrication and installation of items affected.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Advise installers of other work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone veneer assemblies.

B. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

C. Clean the surfaces of each stone before setting by removing foreign matter that might impair the bedding, bonding or appearance of the work. During setting operations dirt or setting materials in contact with exposed surfaces of the stonework shall be removed immediately

D. Do not set patched, chipped, cracked, broken or other defective pieces of stonework. Stains that cannot be removed with clean water and fiber brushes shall be considered a defect, and such pieces shall not be used.

E. Surfaces to which this work is to be secured and the stone surfaces themselves, shall be free from frost, wetness, dirt, grease, visible rust, and foreign materials which will be detrimental to the proper execution of the work.

F. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.

3.3 SETTING OF STONE MASONRY, GENERAL

A. Sort stone before it is placed to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.

B. Set stone to comply with requirements indicated on Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
   1. Shim and adjust anchors, supports and accessories for proper setting and securing of stone.
   2. Completely fill holes, slots and other sinkages for anchors, fasteners and supports with mortar during setting of stones.
   3. Fill holes for dowels with epoxy during setting of stones.

C. Perform necessary field cutting and trimming as stone is set.
   1. Use power saws to cut stone that is fabricated with saw-cut surfaces.
   2. Cut lines straight and true, with edges eased slightly to prevent snipping.

3. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
4. Pitch face at field-split edges as needed to match stones that are not field split.

D. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 1/4 inch at narrowest points or more than 3/8 inch at widest points.

E. Provide expansion joints where indicated on the Drawings. Do not fill with mortar. Install continuous strips of preformed joint filler to allow for installation of backer rod and sealant.
1. Keep sealant joints free of mortar and other rigid materials.
2. Expansion joints are specified in Division 07 Section "Sitework Joint Sealants."

F. Exercise care to protect work already in place. Repair work damaged as a result of these stone operations at no additional cost and satisfaction of Owner.

G. Cover and protect the tops of all unfinished work when not being worked on, by means of waterproof paper, tarps, or other approved means.

H. All Supporting members shall be securely attached and located as shown on drawings and shall be set in true plane.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet.

B. Variation from Level: For horizontal lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet.

C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet.

D. Measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each stone from level, plumb, or dimensioned plane.

E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.

F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

A. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.

B. Anchor stone masonry to unit masonry with corrugated-metal or individual wire veneer anchors unless otherwise indicated. Embed anchors in unit masonry mortar joints or grouted cells for distance at least one-half of unit masonry thickness.

C. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8-inch cover on out-side face.

D. Space anchors to provide not less than 1 anchor per 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.

E. Space anchors not more than 18 inches o.c. vertically and 32 inches o.c. horizontally, with not less than 1 anchor per 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.

F. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.

G. Fill space between back of stone masonry and backing wall with mortar as stone is set.

H. Rake out joints for pointing with mortar to depth of not less than 3/4 inch before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 INSTALLATION OF ADHERED STONE MASONRY VENEER

A. Install flashing over sheathing and behind weather-resistant sheathing paper by fastening through sheathing into framing.

B. Install lath over weather-resistant sheathing paper by fastening through sheathing into framing to comply with ASTM C 1063.

C. Install lath over unit masonry and concrete to comply with ASTM C 1063.

D. Install scratch coat over metal lath 3/8 inch thick to comply with ASTM C 926.

E. Coat backs of stone units and face of masonry backup with cement-paste bond coat, then butter both surfaces with setting mortar. Use sufficient setting mortar so a slight excess will be forced out the edges of stone units as they are set. Tap units into place, completely filling space between units and masonry backup.

F. Rake out joints for pointing with mortar to depth of not less than 3/4 inch before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.7 POINTING

A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch deep until a uniform depth is formed.

B. Point stone joints by placing and compacting pointing mortar in layers not more than 3/8 inch deep. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
   1. Joint Profile: Smooth, flat face slightly below edges of stone.

3.8 ADJUSTING AND CLEANING

A. Remove and replace stone masonry of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Landscape Architect.
   2. Defective joints.
   3. Stone masonry not matching approved samples and mockups.
   4. Stone masonry not complying with other requirements indicated.

B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Landscape Architect's approval of sample cleaning before cleaning stone masonry.
   3. Clean stonework not less than six days after completion of work, using clean water and stiff bristle brushes. Do not use wire brushes, acid type cleaning agents or other cleaning compounds with caustic or harsh fillers.
   4. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

3.9 PROTECTION

A. All stonework in progress shall be adequately protected from staining, scratching, chipping or other damage. Once the stone has been completed, the contractor shall execute the steps necessary to protect the finished areas. Wood, which may stain or deface the stone shall not be used as protection.

B. Provide final protection and maintain conditions, which ensure stonework being without damage, discolorations, or deterioration during subsequent construction and until time of substantial completion.

3.10 EXCESS MATERIALS AND WASTE

A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.

B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches in greatest dimension.
   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earthwork."
   3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

3.11 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day's work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 044310

SECTION 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes all labor, materials, equipment, special tools and services to complete Structural Steel and Other Steel work required for the Project, as herein specified, and as indicated on the Drawings, including but not limited to:

1. All Structural Steel indicated, including design of connections not shown on the Drawings.
2. All accessories, attachments, anchors and rough hardware for structural steel work. Accessories include anchor bolts, embed plates, deck support angles, etc.
3. All Other Steel indicated on the Structural Drawings (S series), including steel stud shear connectors, metal deck, grating, wall girts, screen wall framing, elevator rail supports, sump pit embeds and covers are included under this Section.
4. Prime painting, galvanizing, and Architecturally Exposed Structural Steel where indicated on the Drawings.
5. Quality control, testing and inspection specified to be performed by the Contractor.
6. Coordination with related and adjacent work shown on the Drawings.
7. Setting of items built into cast-in-place concrete or unit masonry and grouting of base plates is not included in this section.
8. Provide temporary guards on the steel frame at the perimeter of each floor and all floor and roof openings; verify scope with CM or GC.

B. The Contract Documents do not differentiate between fabrication and erection work. Should fabrication and erection be performed by separate contractors, the fabricator is responsible for the scope of work of erector and is responsible for resolution of any disputes that may arise.

C. Metal Deck work is to be performed by the Contractor of this Section, including submittals, erection, quality control, testing and inspection specified herein. See the related sections for additional requirements specific to metal deck.

D. Related Sections:

1. Section 033000 - Cast-In-Place Concrete.
2. Section 042000 - Unit Masonry.
3. Section 053000 - Metal Decking.
4. Section 054000 - Cold Formed Metal Framing.
5. Section 055000 - Metal Fabrications.
6. Section 099000 - Painting.

1.3 REFERENCES

A. Comply with the provisions of the following codes, specifications and standards; use the latest edition unless date is indicated. Modifications in this specification, when in conflict with the referenced codes, specifications and standards, shall take precedence.

1. “Kentucky Building Code” (KBC).

2. American Institute of Steel Construction (AISC) ANSI/AISC 303-16: "Code of Standard Practice for Steel Buildings and Bridges," June 15, 2016, as modified by the project drawings and this specification; and modifications in Part 4 at the end of this section.
3. ANSI/AISC 360-16: "Specification for Structural Steel Buildings" and including the "Commentary on the Specification for Structural Steel Buildings", July 7, 2016.
4. Research Council on Structural Connections (RCSC): "Specification for Structural Joints using High-Strength Bolts", June 11, 2020.
5. ASTM International (ASTM) Specifications and references as noted in this Section.
6. American Welding Society (AWS) D1.1/D1.1M-2010: "Structural Welding Code – Steel."
7. AWS-C5.4-93: "Recommended Practices for Stud Welding".
8. ASTM A6/A6M-17: "Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling ".
9. International Code Council Evaluation Service (ICC-ES) AC193: "Acceptance Criteria for Mechanical Anchors in Concrete Elements".
10. ICC-ES AC308: "Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements".
11. Steel Structures Painting Council (SSPC) "SSPC Painting Manual": "Systems and Specifications" and "Good Painting Practice"
12. American Galvanizer's Association (AGA) Recommendations and Suggested Specifications for Hot-Dip Galvanizing.
13. OSHA Regulations, current edition.

1.4 QUALIFICATIONS

A. Contractor must have a minimum of 5 years of successful experience in the type of work required and submit with his Bid evidence of qualifications required herein.

B. Steel Fabricator:

1. 10 years of successful experience in the fabrication of structural steel.
2. Completion of 10 projects of similar size and complexity within the last 5 years. Submit a list of projects and their locations. Each project listed is to have at least 70 percent of the steel quantity of the work being bid.
3. The steel fabricator must be certified under the AISC Certification Program for Structural Steel Fabricators – Standard for Steel Building Structures and Standard for Steel Bridges for the pedestrian bridge. Evidence of current auditing by an independent, approved inspection agency that the fabricator has established quality control procedures comparable to the AISC program may be considered in lieu of AISC certification.
4. Steel fabricator must have an established in-house quality control program for shop drawing production, material tracking, material inspection, welder certification, weld quality, and fabrication accuracy. Fabricator shall be registered and approved per Section 1704.2.5 of the Building Code, and submit required certificate of compliance. Failure to meet these qualifications will require additional inspections prescribed in Building Code Chapter 17 to be performed by the Owner's inspection agency at the Contractor's expense.

C. Steel Erector:

1. 5 years of successful experience in the erection of structural steel.
2. Submit a list of 6 similar completed projects; include key personnel, and equipment.
3. The steel erector must be certified under the AISC Certification Program for Structural Steel Erectors – Standard for Structural Steel Erectors. Evidence by an independent, approved inspection agency that the erector has established quality control procedures, including weld testing, comparable to the AISC program may be considered in lieu of AISC certification.

1.5 SUBMITTALS

A. The Contractor shall review submittals for compliance with the Contract Documents, accuracy, dimensions, fit-up, construct-ability, and coordination with other work. The structural engineer's review will be for general intent of strength and serviceability only.

B. Submit for record with Bid evidence of Contractor's, Fabricator's and Erector's qualifications.

C. Submit for record evidence of Steel Fabricator's and Erector's quality control programs, procedures and certifications showing conformance with Chapter 17 of the Building Code.

D. Prior to preparing shop drawings, submit for record calculations of connections designed by the contractor, prepared, signed and sealed by a Professional Engineer registered in the state in which this project is located.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

F. Submit detailed drawings, include:

1. Complete details and schedules for fabrication and shop assembly of all members.
2. Complete details, schedules, procedures and diagrams for field erection.
3. Temporary bracing and shoring, including calculations.
4. Limits of prime painted surfaces vs. bare steel, show also on overall plans.
5. Evidence that shop drawings (piece and erection drawings) have been reviewed by the Fabricator's Professional Engineer prior to submittal.
6. Layout and installation drawings for all anchor bolts and other items to be embedded in concrete or masonry work by others. Drawings shall dimension the locations of all embedded items noting pertinent tolerances for the installation.

G. Prior to fabrication, submit for record two copies of producer's or manufacturer's specifications and installation instructions for the following items. Include laboratory test reports and other data for evidence as required to show compliance with these specifications (including specified standards). Indicate by transmittal form that copies of each applicable instruction have been distributed to fabricators, installers and erectors.

1. Structural steel: Submit the mill report for each heat of steel used prior to the start of fabrication. Mill reports shall show chemical analysis to include C, Mn, Cr, Mo, V, Ni, Cu and full mechanical properties of the structural steel provided. For unsatisfactory mill test report, retest or reject steel.
2. High-strength bolts, including nuts and washers: Submit certification of inspection test report for each production lot indicating proof load, tensile strength and hardness of high strength bolts. For unsatisfactory test reports, retest or reject bolts.
3. Welding materials and procedures: Submit written welding procedures for all welding on the project, both shop and field. Procedures for complete penetration welds shall include test records to verify the heat-affected zone and show that parent metal for the test meets the grade specified for the project. Welding sequence and procedures are to minimize the effect of weld shrinkage, residual stresses, and to maintain erection tolerances.
4. Mechanical and adhesive anchors, include manufacturer's evaluation reports (ESR) and specific project locations and conditions where proposed for use.
5. Primer paint and surface preparation procedures.
6. Hot-dip galvanizing and surface preparation procedures

H. During fabrication and construction, Contractor shall submit quality control, inspection and test reports immediately to the Owner's representative and inspector, with a copy to the structural engineer within one week. Include:

1. Welder certification for shop and field welders.
2. Welding, fabrication and erection inspection reports.
3. Welding verification inspection and test reports for all shop and field welds.
4. Shear stud tests and installation reports.
5. Bolt and anchor tests and installation reports.
6. Contractor's weekly inspection report summary.

I. Submit record drawings of the erected steel members to the Owner's representative.

J. Submittals for record, informational submittals, compliance reports and inspection reports will not be reviewed or returned.

1.6 CONTRACTOR DESIGNED CONNECTIONS

A. The Contractor shall be responsible for the structural design and detailing of all connections not shown on the Drawings, in addition to detailing those connections shown on the Drawings. The structural design and detailing of connections shall be in accordance with the following provisions and those identified on the drawings.

B. Design of all connections shall be under the direct supervision of a suitably qualified and experienced structural Professional Engineer, registered in the state in which this project is located, who shall sign and seal the shop drawings of the work for which he is responsible.

C. The Contractor shall design connections using the concepts, specific configuration details, and typical connection notes indicated on the Drawings as minimum requirements.

D. The Contractor shall prepare sketches of all connection details, with locations clearly marked on plans and elevations, and submit these in conjunction with pertinent design notes and calculations for review by the Owner's structural engineer, prior to preparing and submitting related shop drawings.

E. All beam connections shall be simple beam connections unless indicated otherwise on the drawings. Simple beam connections shall be designed for the reaction noted on the Drawings, or where no reaction is called out, for the reaction from the maximum uniform load capacity of the beam. Connections shall also meet the minimum requirements indicated on the Drawings.

F. All gusset, brace and truss member connections shall be designed for the member forces shown on the drawings, or full capacity of the members' flanges if no forces are shown. Connections shall also meet the minimum requirements indicated on the Drawings.

G. Design of connections includes the analysis and design of connected material to determine requirements for stiffeners, doubler plates, etc. Even if doubler plates and stiffeners are not shown on the contract documents they may be required based on the Contractor's connection design and shall be included in the work.

H. All member splices shall be designed to develop the full capacity of the smaller member.

I. The Contractor may propose alternate connections to those shown on the Drawings by submitting sketches, design notes and calculations of all alternate connection details, with locations clearly marked on plans and elevations, at the beginning of the project. Acceptance is at the discretion and judgment of the Owner's structural engineer. Shop drawings submitted by the Contractor showing either details or alternate connections not previously reviewed in accordance with these provisions shall be subject to rejection.

1.7 QUALITY CONTROL

A. Personnel performing the work shall have experience relevant to anticipated conditions, materials, installation requirements and all special techniques involved. Contractor shall have an experienced foreman or superintendent who will be present while work is performed.

B. The Contractor is responsible for and shall perform quality control, testing and inspection of all work as required by the Contract Documents, referenced codes, specifications and standards. Contractor shall employ qualified inspectors to perform inspections, tests and quality control daily. Submit reports weekly.

C. The Contractor shall reject and replace work that is not in conformance.

D. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure". All welding shall be performed by operators who are qualified for the types of welds used. Verify each operator's qualifications with Owner's inspector prior to using in production.

1. Welders shall retake qualification test if, as determined by the Owner's representative, there is a reasonable doubt as to the proficiency of the welder. If the welder does not requalify he/she shall not perform welding on this project.
2. The Contractor shall pay all costs associated with welder qualification.

E. Qualify mechanical fasteners, mechanical anchors, adhesive anchors and installation processes in accordance with manufacturer's engineering reports and code recognized approval procedure. Installers shall be certified by the manufacturer or an independent organization. Verify each installer's qualifications with the Owner's inspector prior to using in production.

F. Source quality control: All materials shall be Identifiable. Unidentifiable materials shall be tested or rejected.

1. Materials delivered with certificate are classified as Identifiable; those without certificates are classified as Unidentifiable.
2. Test material not identifiable by heat number and mill test, or another acceptable manufacturer's identification per ASTM A370-17. Testing to be performed by Contractor's testing agency as follows:
    a. Shear connectors: Each lot of 100 studs; tensile tests on 3 finished studs per AWS.
    b. Structural shapes and plates: From coupons taken from material; one tensile test and one bend test per 5 tons of each shape.
    c. High strength bolts: Each lot of 100 bolts; tensile tests on 2 bolts in full size and one tensile test on a ½" diameter machined specimen.
    d. Other materials: Test as directed.

G. The Contractor shall arrange for review by the Owner's inspection agency. The Contractor shall not rely on the Owner's inspector for the Contractor's quality control. Contractor shall furnish Owner's inspector with the following:

1. One complete set of fabrication and erection drawings.
2. Material bills and mill test reports.
3. Information regarding time, place of rolling and shipment of materials to shop.
4. If requested, representative sample pieces for testing.
5. Full and ample means and assistance for testing materials.
6. Complete set of welding procedures.
7. Welder qualifications.
8. All manufacturers' installation instructions.
9. Anchor installer qualifications.
10. AISC fabricator certification documents QA/QC manual and most recent AISC audit.

11. AISC erector certification documents QA/QC manual and most recent AISC audit.
12. Qualifications for Contractor's quality control personnel and independent testing agency.
13. Reports for all quality control, tests and inspection by Contractor.

H. Structural inspections required by Chapter 17 of the Building Code shall be performed by an approved inspector retained by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Material storage: Protect structural steel members and packaged materials from corrosion and deterioration. Store off ground and pitched to drain off water.

B. Do not store materials on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

C. Deliver welding electrodes to job in unbroken packages bearing name of manufacturer. Special handling for electrodes is required per AWS. Provide and use an oven for electrodes requiring continuous drying prior to use.

1.9 ERECTION ENGINEERING

A. The Contractor shall be solely responsible for the procedure, means and methods of erection as well as safe erection of the work. The Contractor shall be solely responsible for compliance with all pertinent statutes, regulations and/or ordinances with respect to the erection of the work.

B. The structural engineer of record has analyzed the completed steel structural system for service conditions only. The Contractor shall analyze the steel structure at various stages of his erection to ensure stability of the structure and/or its sub-assemblies as well as to ensure that none of the temporary or permanent components of the structure are over-stressed.

C. The Contractor shall be solely responsible for the design of any shoring towers, temporary braces, and/or temporary guys including the foundations and/or anchorages thereof that may be required to execute the work. The Contractor's erection analysis, procedures and drawings shall be prepared under the supervision of a suitably qualified and experienced Professional Engineer, registered in the state in which this project is being constructed, who shall sign and seal the erection drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural steel:

1. Wide flange shapes: ASTM A992 (Fy 50ksi).
2. Steel pipes: ASTM A53, Type E or S, Grade B (Fy 35ksi). Spiral Pipe is not permitted.
3. Hollow structural sections (HSS): ASTM A500, Grade C (Round Fy 46ksi; Square and rectangular Fy 50ksi).
4. Other rolled shapes, plates and bars: ASTM A36 (Fy 36ksi) unless noted otherwise.
5. Plates and bars noted Grade 50: ASTM A572 (Fy 50ksi).
6. All steel to be welded shall conform to chemical and metallurgical limitations specified in AWS D1.1 and D1.3.
7. Special care shall be used to select plate and rolled sections free from internal laminations. The Contractor shall assure compliance with provisions for lamination inspection.

8. All end plates and other plates and shapes exceeding 1" in thickness and intended to receive other material welded normal to them with complete penetration welds or fillet welds exceeding 5/16" in size, shall be fully killed and be capable of through-thickness tension test reduction of area values of 20 percent minimum.
9. Comply with AASHTO Fracture Toughness requirements for Bridge Steels ASTM A709 “Zone 2 Welded Fractures Critical” where noted on structural drawings or below. Provide Charpy V-Notch Impact testing with samples from the core of shapes and plates. Use frequency “P” for the Charpy testing. Steel shall be silicon killed, fine grained. Fracture critical steel includes:
    a. Steel noted on plans or details as “FC”.
    b. Top and bottom chords of trusses.
    c. Top flange and bottom flanges of plate girders, where flange thickness exceeds 1½”.
    d. Flanges of rolled or built-up columns where flange thickness exceeds 1½”.
    e. Plates exceeding 1” in thickness with perpendicular attachments, such as base plates and end plates, by penetration welds or fillet welds exceeding 5/16” in size.

B. Threaded fasteners:

1. Anchor rods: ASTM F1554, Fy 36ksi, minimum. Supply all anchor rods with two heavy-hex nuts, one nut to be used for base plate leveling, unless otherwise shown.
2. Structural bolts: ASTM F3125, grade F1852, type 1, 120 ksi, quenched and tempered medium-carbon steel, 3/4” min. diameter, tension control assemblies with heavy-hex nuts and hardened washers. Use tension control assemblies conforming to ASTM F1852 everywhere access permits. For all bolts unless noted otherwise.
3. Structural bolts noted A490 or F2280: ASTM F3125, grade F2280, type 1, 150 ksi, quenched and tempered alloy steel 3/4” min. diameter, tension control assemblies with heavy-hex nuts and hardened washers. Use only where grade A490 or F2280 bolts are noted on the drawings or acceptable to the engineer of record by written request. Use tension control assemblies where access permits.
4. Where access prevents the use of a tension control bolt, use load indicator washer conforming to ASTM F959, in accordance with "Specification for Structural Joints Using High-Strength Bolts” (6-11-2020), paragraph 8.2.4, and mark bolt(s) for inspection. Load indicator washers shall be self-indicating to allow visual observation, and provided with 1 or more additional flat washers, based on hole type, as required by the manufacturer. Install with grade A325 (or A490 where indicated) heavy-hex structural bolts, A563 heavy-hex nuts and F436 hardened washers.

C. Welding electrodes:

1. Use electrodes as required by AISC “Specification for Structural Steel Buildings” and the AWS Code. As minimum use E70 XX electrodes, low hydrogen.
2. For complete penetration welds of beams, columns and trusses, use E70TG-K2 electrodes or better.
3. Charpy V-Notch Impact requirements for welds for and/or to Fracture Critical Steel shall be in accordance with AASHTO/AWS Bridge Welding Code as required to match that specified for the parent material.

D. Steel stud shear connectors: ASTM A108 or A29, Grades 1010 - 1020, Type B, and AWS D1.1.

E. Mechanical and adhesive anchors: ICC-ES approved with current ESR for cracked concrete, zinc coat unless noted otherwise, galvanize or use stainless steel where exposed to weather. Type and embedment depth into concrete as indicated on the drawings, if not shown embed 8 x diameter, but never less than the manufacturer's recommended standard embedment. Manufacturers may include:

1. Hilti, Inc.
2. Powers Fasteners, Inc.

3. Simpson Strong-Tie Company, Inc.

F. Galvanizing: ASTM A123. Galvanize bolts and washers connecting galvanized members per ASTM A153, Class C. Touch up with galvanizing repair compound.

G. Galvanizing repair: Zinc rich galvanize repair compound containing 90% minimum zinc by weight in the dried film. Comply with DOD-P-21035 or The Society for Protective Coatings, Paint Specifications No. 20 (SSPC-PS 20).

H. Structural steel primer paint: One coat rust inhibitive primer, gray. Paint shall be weldable with negligible effect on weld integrity. Where steel is AESS or field painted: One coat of zinc rich primer, refer to Specification 099000 Painting, and verify compatibility with topcoats.

2.2 FABRICATION

A. The fabricator shall track materials, assemble, inspect, and test the work under supervision of qualified quality control personnel, who shall ensure conformance with established written procedures to meet the design requirements. Inspector shall make written daily reports of progress, deviations, deficiencies, and corrections, and confirm work is satisfactory. Submit reports weekly.

B. General:

1. Fabricate items of structural steel in accordance with this specification, the referenced codes and standards, the contract design drawings, and the final reviewed shop drawings.
2. Detail and fabricate steel to allow for erection in compliance with OSHA regulations. Complete detailing for compliance, including modification of details shown on the contract drawings where required.
3. Provide camber in structural members as shown. Unless otherwise shown, fabricate beams with mill camber up.
4. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.
5. Where finishing is required, complete the assembly, including connections and welding of units, before start of finishing operations.
6. Furnish main steel members in one piece without splicing unless otherwise shown or approved.
7. All exterior hollow steel members shall be completely sealed air tight with welded plates.
8. Provide holes for drainage in any exterior members that will collect and hold water, either during construction or in final structure.
9. Mill all surfaces in contact bearing. Cut and fit bearing and column stiffeners and straighten base plates to provide full bearing over entire cross-section.
10. Seams in hollow structural shapes shall be oriented away from public view.
11. Plates that are subjected to axial tension shall be oriented with the roll direction as shown on the Drawings. Where not shown, orient the roll direction nominally parallel to the direction of primary tensile stress in the plate.

C. Connections:

1. Provide welded shop connections unless otherwise shown.
2. Provide bolted field connections unless otherwise shown.
3. Provide high-strength bolts for all bolted connections.
4. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
5. Comply with AWS D1.1 Code for procedures, preheat, appearance and quality of welds, including methods used in correcting welding work. Assemble and weld built-up sections by methods that will produce true alignment of axis without warp.

6. Consider toughness and notch sensitivity of steel in formation of the welding procedures to prevent brittle and premature fracture during fabrication and erection. Toughness requirements are to match those of the parent metal. Weld in a manner to minimize accumulation and concentration of through-thickness strains due to weld shrinkage. Sequence welds in a manner to reduce residual stresses caused by welding to a minimum value.

D. Provisions: Provide holes, weld nuts, welded studs, etc., required for securing other work to structural steel and for the passage of other work through steel framing members as required.

2.3 FINISHING

A. Galvanize structural steel where indicated on the Drawings, including all exterior plates and shapes, mechanical support frames, ledge angles, lintels, and lintel plates.

1. Clean steel to be galvanized of foreign substances per ASTM A385. Power tool clean all welds and adjacent areas to remove flux and splatter before galvanizing.
2. Provide 2.3-oz./sf zinc coating per ASTM A123.

B. Prime paint structural steel where indicated on the Drawings, do not paint at field weld locations or slip critical faying surfaces. Do not paint galvanized steel or steel which is to be fireproofed, U.N.O.

1. Surface Preparation (after SSPC SP-1 Solvent Wipe):
   a. Where standard primer indicated - SSPC SP-3 “Power Tool Cleaning.”
   b. Where indicated “Architecturally Exposed” - SSPC SP-6 “Commercial Blast Cleaning.”
2. Immediately after surface preparation, apply structural steel primer paint in accordance with the manufacturer’s instructions and at a rate to provide a uniform dry film thickness of 2.0 mils. Use painting methods that will result in full coverage of joints, corners, edges and all exposed surfaces. No sags or runs permitted on steel that will be exposed in the finished work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Establish permanent benchmarks, in addition to those provided, as needed for accurate erection of structural steel.

B. Field survey and measure all existing conditions prior to preparation of shop drawings. Employ a licensed land surveyor for all steel erection work.

C. Check elevations of concrete bearing surfaces and locations of anchor bolts and similar devices before fabrication work and report dimensional discrepancies to the Owner’s representative. Do not proceed with fabrication until corrections have been made or until compensating adjustments to structural steel have been approved by the Owner’s structural engineer.

D. Furnish templates and detailed setting drawings as needed to ensure accurate positions of anchors.

E. Verify positions of anchor bolts before fabrication of steel. Report deviations from design locations and submit written recommendations for corrections.

F. Notify the Owner’s representative in writing of conditions that would hinder proper and timely installation, or impair performance of finished work.

3.2 INSPECTION BY CONTRACTOR

A. Quality control, testing and inspection by Contractor for fabrication and erection shall conform to requirements of the Contract Documents, referenced codes, specifications and standards; and the following:

1. Inspection by Contractor shall be at Contractor's expense, by a testing agency or qualified inspector other than that employed by Owner, and shall be performed before Owner's inspection of material involved.
2. Contractor shall submit weekly written inspection report summaries to the Owner's representative, inspector, and structural engineer. In general, these reports shall:
    a. Verify that welders are certified.
    b. Confirm use of qualified welding procedures and:
        1) Welding equipment is used per manufacturer's recommendations.
        2) Proper use of drying oven and preheating.
        3) Fit-up and structural steel compliance with the specified dimensional standard.
        4) Proper use of run-out plates.
    c. Inspect every weld for quality and conformance. Systematically record welds, include:
        1) Location and type of weld.
        2) Weather conditions during welding.
        3) Identification marks of welders.
    d. Include shear studs, bolts, anchors and other items.
    e. Report all defects and deficiencies.
    f. Report and describe how corrections were made.
3. Acceptance criteria used for the inspection of welds shall be as specified in AWS D1.1.

B. Visually inspect all material for defects before and after cleaning. Material with visible defects shall be rejected.

C. Lamination inspection: All wide flange or plate material 1 inch or greater in thickness within 6 inches of complete penetration welds for flange or perpendicular plate connections shall be ultrasonically tested for laminations per ASTM A578, Level II. Perform such testing before fabrication and test flange and plate material adjacent to and behind welds again after welding. Inspect all material visually for lamellar tears.

1. Material in which defects are found shall be rejected and replaced with satisfactory new material, or repaired by welding, subject to approval of the Owner's structural engineer. Repaired material shall be re-tested at no additional cost to Owner.

D. Penetration welds: Inspect all (100%) complete and partial penetration welds visually. Inspect all (100%) complete penetration welds by ultrasonic or radiographic tests for entire length of weld. All inspections to occur a minimum of 24 hours after completion of welding.

1. Material that fails testing shall be corrected and re-tested over entire length of weld until satisfactory results are achieved.
2. Ultrasonic testing shall be performed by a specially trained, qualified technician to operate equipment, examine welds, and maintain a record of welds examined, defects found, and dispositions of defects.
3. When ultrasonic indications arising from weld root can be interpreted as either a weld defect or backing strip, the backing strip shall be removed and the weld shall be re-tested.
4. Ultrasonic instrumentation shall be calibrated by technician to evaluate the quality of welds per AWS D1.1.
5. Other methods of inspection, for example, x-ray, gamma ray, magnetic particle, or dye penetrant, may be used on welds if acceptable to the Owner's structural engineer.

E. Fillet welds: Inspect all (100%) shop and field fillet welds visually for proper size, quality of weld and placement per reviewed shop drawings. Inspect 5% of a mix of field and shop welds by magnetic particle method, ASTM 109.

F. Shear studs: Test and install as specified in AWS D1.1 requirements for stud welding.

G. High strength bolted connections: At beginning of bolting operations, verify bolt installation techniques and test bolts in field conditions for proper pretension per manufacturer's requirements. Retest when changes in bolt lots, lubrication and weather exposure conditions occur. Inspect all bolted connections for bolt size, quantity, type, and tension.

H. Mechanical and adhesive anchors: Verify installers are certified and materials are used in conformance with manufacturer's recommendations. Observe hole preparation and installation technique at all anchors as work progresses. Proof test 5% of all anchors in each condition, distributed throughout the project, and at least 1 anchor in each steel framing connection. Amount of testing shall be increased if failures occur.

3.3 INSPECTION BY OWNER

A. The Owner will engage an independent inspection agency to perform shop and field verification inspection services in accordance with referenced standards. The Contractor shall schedule and coordinate inspections.

1. The Owner will pay costs of initial inspection.
2. Material that fails inspection shall be corrected by Contractor and re-inspected until satisfactory results are achieved.
3. The Contractor shall pay costs incurred by Owner's inspection agency, architect, and/or engineer for re-inspection of corrections made because of failed initial tests.
4. Inspection may be performed in shop or field.
5. Contractor shall perform all necessary preparatory work for inspection such as cleaning, marking and removal of back-up bars, if needed, without additional costs.
6. Acceptance criteria used for the inspection of welds shall be as specified in AWS D1.1.

B. Inspections do not relieve Contractor of responsibility for contract compliance. The Owner's representative shall have the right to inspect or test work and reject faulty materials of workmanship at any time before final acceptance.

C. General:

1. Review Contractor's quality control program.
2. Review Contractor's fabrication and erection inspection reports for compliance with the requirements of AWS D1.1 and Inspection by Contractor, above.
3. Verify welder's certifications.
4. Provide required verification inspections.
5. Record types and locations of all defects discovered, report such discoveries to Contractor, and record corrections performed. Reports will be made not less than weekly to the Owner's representative.

D. Penetration welds: All (100%) complete and partial penetration welds shall be visually inspected. Twenty percent (20%) of complete penetration welds shall be inspected ultrasonically for the entire length of weld. Columns, beams and plate material perpendicular in connections with penetration welds will be checked for lamellar tears. Further inspection may be required if unacceptable welds or material are found. Contractor shall pay cost of such additional inspection. Rejection of any portion of a weld shall require re-inspection of 100% of that weld after repair.

E. Fillet welds: Twenty percent (20%) of the field-placed fillet welds shall be visually inspected. Five percent (5%) of shop-placed welds shall be visually inspected to verify fabrication quality control. Inspector is to verify placement of welds per reviewed show drawings, as well as proper size and quality of weld.

F. Shear studs: At start of shear stud installation, Owner's inspector shall observe construction installation and the Contractor's quality control, specified in AWS D1.1, (requirements for stud welding) and perform the following additional requirements:

1. 100% of the first 100 studs and 50% of the next 200 studs installed shall be bend tested to a 15-degree angle. If more than 4 studs fail, installation shall cease until installation procedures have been adjusted to achieve satisfactory results, and Contractor shall bend test all studs installed to date.
2. For balance of job, bend tests at least 10% of all field-applied shear studs. A failure rate of not more than 2% of studs tested will be acceptable.
3. Contractor shall correct failed stud installations.
4. Owner's inspector shall check stud installation using the contract drawings and reviewed shop drawings to verify quantity and location of studs.
5. If operators or equipment are changed or the deck becomes wet, testing shall revert to that at the beginning of the project.

G. High strength bolted connections:

1. Observe Contractor's testing and installation techniques meet manufacturer requirements.
2. Visually inspect all bolted connections for bolt size, quantity, type, and tension. Inspection shall also confirm that bolts' threads are not in the shear plane where required.
3. Two bolts per thousand of each grade and type shall be removed from ongoing field bolting operations and checked for proper tension when installed per manufacturer's instructions. Condition of bolts tested shall match field conditions.
4. One bolt per two thousand of each grade and type shall be randomly tested for material requirements of ASTM F3125; including, but not limited to, chemical composition, hardness, dimension, and tensile strength.

H. Mechanical and adhesive anchors: Verify installer certification. As work progresses, observe installation for conformance with manufacturer's recommendations and witness Contractor's proof testing.

I. Remedies: Defective material shall be removed and replaced by the Contractor unless corrective procedures are permitted by the engineer. Corrections shall be tested at Contractor's expense until satisfactory results are achieved.

3.4 OXYGEN (FLAME) CUTTING

A. Manual oxygen cutting shall be done in the shop only and only with a mechanically guided torch. Alternatively, an unguided torch may be used provided the cut is not within 0.5 inches, of the finished dimension and the final removal is completed by chipping or grinding to produce a surface quality equal to that of the base metal at cut edges.

B. Control process to prevent excessive hardening of edges of steel where material is to be welded or is subject to axial tension.

C. Clean and repair all cut edges by welding and/or grinding to remove all gouges, cuts, burrs, and jags to meet the requirements of AWS D1.1.

D. Re-entrant cuts shall have as large a radius as possible without over cutting.

E. The use of oxygen-cut holes for bolted connections is not permitted under any circumstances. Violation will be cause for the rejection of any pieces in which oxygen cut bolt holes exist.

F. Oxygen cutting of structural steel in the field is not allowed except with the written consent and approval of the Owner's structural engineer.

3.5 BASE PLATES AND ANCHORS

A. Furnish anchor rods, and other items built into cast-in-place concrete or unit masonry to appropriate installer, together with template and detailed setting drawings required to assure accurate positioning of the items.

B. Templates, furnished by the Contractor for all anchor rods, shall be used to set the anchors. Templates shall be fabricated from steel plate, minimum thickness 1/8". The installer is to check carefully the setting of the bolts to the proper position prior to placement of concrete. Anchor bolts shall have nuts and washers. Damaged threads shall be repaired or re-cut to permit full tightening of nuts.

C. Anchors, embed plates and other items shall not be welded to reinforcing steel.

D. Base plates supported on concrete, whether shop attached or shipped loose, shall be furnished with and set upon leveling nuts. Base plates shall have holes for bleeding off air during grouting.

E. Setting base plates:

1. Prior to setting, clean existing and new concrete surfaces and roughen with bush hammer to improve bond. Clean the bottom surface of the base plates. Chip out any areas required to set shear lugs, making sure that the reinforcing steel is not damaged.
2. Tighten anchor bolts after the base plates have been positioned and leveled. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base plate.

3.6 BOLTS

A. Assemble joint using drifts to obtain correct alignment.

B. Fit bolts. Use hardened washers under the turned part. Lubricate bolts to prevent nuts seizing on the bolts. Lubricate with a liquid high-pressure lubricant and apply only to the outstanding threads after the bolts have been inserted through the steel work, taking care to prevent lubricant getting between the plies of the joint.

C. Tighten bolts sufficiently in an appropriate sequence to bring joint surfaces into uniformly close contact.

D. Pretension all high strength bolts to the appropriate levels using tension control bolts or load indicator washers.

E. Mark each bolted connection when all bolts in the connection are prestensioned. Do not touch-up paint or cover until bolts have been inspected. The inspector shall mark connections that have been inspected.

3.7 MECHANICAL AND ADHESIVE ANCHORS

A. Post-installed anchors into concrete shall only be used as shown in the structural details, and only as submitted and reviewed. They shall not be used where cast-in-place anchors are required.

B. Adhesive anchoring shall not be used in overhead or upward conditions. Adhesive anchors in near horizontal positions shall use a hybrid adhesive.

C. Anchors shall be ICC-ES approved with current ESR for cracked concrete, zinc coat unless noted otherwise, galvanize or use stainless steel where exposed to weather.

D. Anchor size, type, embedment depth into concrete, edge distances and spacing are crucial, and shall be as indicated on the structural drawings. If not shown, embed 8 x diameter, but never less than the manufacturer's recommended standard embedment, with edge distances at least 8 x diameter and spacing at least 12 x diameter.

E. The Contractor shall arrange for a representative of the manufacturer to provide onsite installation training for their products. Adhesive anchor installers shall also be certified by a recognized program, such as by ACI and CRSI. Submit documentation of training and certification of personnel prior to performing such work. Provide copy to the Owner’s inspector.

F. Holes into concrete must not interfere with reinforcing bars. The Contractor shall review the structural drawings and use ferro-scan, chipping or other means to locate reinforcing bars in the area. Space holes to fit around rebar and fabricate fixture to match.

G. Install in strict accordance with the manufacturer’s ESR, written instructions and recommendations. Holes in concrete shall be the proper size and thoroughly cleaned with all dust removed. Drill holes using a hollow bit and functioning vacuum system, then brush and blowout with compressed air.

H. Install into dry concrete in clean, dust free holes using method and procedure that meets manufacturer’s recommendations including temperature range, humidity, installation time and cure time. Follow the manufacturer’s printed installation instructions. Instructions must be included in the anchor packaging.

I. Provide standard size holes in the fastened steel element (1/16” larger than anchor diameter). Mark and drill all holes in the concrete before setting steel. Some anchors may be set after steel is in place to allow some alignment. Do not oversize holes. Use washers beneath nuts.

J. Contractor shall perform quality control, inspect and test anchors.

K. When exposed to view in the final structure, bolts shall be of a length that will extend entirely through but not more than ¼-inch beyond the nuts unless otherwise shown on the drawings.

3.8 WELDING (APPLIES TO BOTH SHOP AND FIELD WELDS)

A. Weld using only qualified and approved AWS procedures. Use drying oven for electrodes and preheat steel per AWS requirements.

B. Weld in manner to prevent warping or distortion of finished product. Use jigs that will not restrain piece from moving during welding or cooling after welding. Sequence weld passes at a joint to prevent excessive heat build-up or cause shrinkage cracks to form. Adequately peen and brush joint after successive passes to prevent slag inclusions, open pockets, and inadequate fusion.

C. Provisions shall be made in detailing of lengths of members for dimensional changes as a result of shrinkage stresses so as to provide required finished dimension.

D. During assembling and welding, hold components with adequate clamps or other means to keep parts straight, accurately aligned and positioned, and in close contact. Plan sequence of field welding to minimize locked-in stresses and distortion.

E. Provide adequate screening from wind for field welding.

F. Cut out defective welds or parts of welds with a chisel or air arc, and re-weld.

G. Tack welds and temporary welds made in material that will be subject to tension or architecturally exposed shall be removed and ground smooth.

H. Fillet weld sizes shall comply with the minimum requirements of the AWS D1.1 Code regardless of smaller sizes being noted on the contract design drawings.

I. Where structural steel members are to remain exposed in the finished work, welds exposed to view shall be uniform and smooth. Penetration welds shall not project more than 1/16” above the adjacent surfaces where exposed to view. Grind welds if necessary to meet this provision.

J. Remove run-off tabs and grind surfaces smooth where the tabs interfere with architectural treatment or are exposed to view in the final structure. Remove backup bars where exposed to public view in the completed structure.

K. All exposed to public view or to weather welds shall be continuous. In the event that an intermittent weld is specified, provide seal welds between.

L. Heavy sections and those weldments having a high degree of restraint must be welded in a sequence with the proper preheat such that no permanent distortion occurs. Submit a welding sequence for review for these types of connections.

M. Splices of members in tension, all members of moment frames, and all bracing members of braced frames that are made from plates more than 1½” thick or ASTM A6 Group 4 or 5 rolled shapes shall develop the force due to the design load, but not less than 50% of the effective strength of the member. A smaller percentage may be used only if it is justified by engineering analysis that considers other factors including handling, shipping and erection.

3.9 ERECTION

A. Comply with this specification, the referenced codes and standards, the contract design drawings, and the final shop drawings. Comply with requirements of governing authorities, including requirements for work above public streets and sidewalks.

B. Provide all temporary shoring and bracing members as required, with connections of sufficient strength to bear imposed loads, including all construction loads and Building Code wind loads. Comply with FM bulletin I-7:

1. The structural steel framework is "non-self-supporting" and therefore requires temporary support bracing. Do not remove temporary support members and connections until the structure is complete and functioning as the designed unit. The unit is complete when all structural steel and metal deck is completed, and supporting concrete, including walls, floor diaphragms and slabs on metal deck are placed and cured.
2. Members and connections shown and reviewed via the shop drawing process are analyzed only for loads due to the final structure. Loads imposed on the connections and members during the erection process, and safety of erection of same, shall be responsibility of the structural steel Contractor.
3. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.

C. Provide temporary planking and working platforms as needed for the work. Provide temporary guards on the steel frame at the perimeter of each floor and all floor and roof openings.

D. Field assembly:

1. Set structural frames accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignments.
2. Level and plumb individual members of the structure within specified AISC tolerances, unless more restrictive tolerances are specified on the drawings.
3. Splice members only where shown or specified.
4. On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth.
5. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignments and the removal of paint on surfaces adjacent to field welds.
6. Do not enlarge unfair holes in members by burning or by use of drift pins except in secondary bracing members. Ream holes that must be enlarged to admit bolts. Where a hole is required to be enlarged by more than 3/32-inch ream to and use the next larger bolt size.
7. Do not use gas cutting torches in the field for correcting fabrication errors, except on secondary members that are not under stress. Finish gas-cut sections equal to a sheared appearance.

E. Shear connectors: Inspect composite deck installation before installation of shear studs and report adverse conditions to the Owner's representative. Deck shall be in continuous contact with top of beam flanges, embossing flattened or removed, and no lap joints. Do not start work until such conditions are corrected. Start of work is acceptance of conditions and responsibility for corrections.

1. Areas of beams to which studs are welded directly shall be free of loose mill scale, and heavy rust that would adversely affect welding. Where studs are to be welded through metal deck, top flanges of beam shall be free of dirt, moisture and debris before installation of deck. Remove water in deck flutes so that it is not trapped between deck and beam.
2. Field weld studs to structural members after steel framing and metal deck are in place.
3. Workmanship shall be in accordance with the AWS D1.1 Code. Quality control, including inspection and testing, shall be in accordance with this specification and AWS D1.1 Code.

3.10 CLEANING

A. Following erection, clean all steel work of mud and dirt accumulated during erection. Thoroughly clean and remove dirt, debris, oil, water, and other foreign material from steel and leave ready for painting or fireproofing.

B. Field coat all damaged and abraded areas of galvanized steel with galvanizing repair compound applied per manufacturer's instructions.

C. Field prime paint all welded, damaged and abraded areas and previously unprimed steel at welds, slip critical connections, etc. with same material used for shop painting.

PART 4 - ADDITIONAL REQUIREMENTS

4.1 MODIFICATIONS TO THE AISC CODE OF STANDARD PRACTICE

A. Modifications to the AISC Code of Standard Practice are described throughout the Contract Documents and within this Section. Requirements of the Contract Documents that modify or conflict with referenced standards shall take precedence over the standard. Where a numbered paragraph is noted below, the requirements of said paragraph in the AISC "Code of Standard

Practice for Steel Buildings and Bridges", June 15, 2016, and its Commentary are deleted and the requirements noted herein shall apply.

1.4.1 Contract documents for structural work shall be issued as printed or printable contract documents. Requirements shall be the plain text and drawings printed on the documents. Digital information in any electronic file or model shall not be used in lieu of or for augmentation of the printed contract documents.

1.8.1 (a) Steel Contractor shall provide, install and remove any shoring necessary for the installation of new structural steel.

1.8.3 Fabricator shall survey and determine existing dimensions and elevations required for structural steel work or arrange for field verification through the GC or CM, with no additional cost to the Owner.

3.1 (j) Dimensions and elevations for structural steel may require coordination with architectural components, mechanical requirements, and existing conditions and may not be completely shown on the structural drawings.

3.1.1.1 Connections shall be as indicated in the design documents with engineering design and detailing of all parts, copes, stiffeners and welds completed by the Fabricator using option 2 and option 3.

3.1.1.2 Should connection configurations differing from the design documents be needed, Fabricator shall propose and submit details prior to shop drawing preparation. The submittal shall clearly define the location of all connections submitted for review. See Section 4.2.3.

3.1.1.3 If additional information or clarifications regarding connections is desired, the Fabricator shall contact the structural engineer of record.

3.1.2.1 Connection design shall account for concentrated forces using option 3B. Even if reinforcement details and quantities are not shown on the design documents, reinforcement may be required by connection design and shall be included in the work and bid.

3.2 Architectural, Electrical and Mechanical Design Drawings and Specifications

Architectural, Electrical and Mechanical Drawings may be used as a supplement to the Structural Drawings to define detail configurations and construction information, including dimensions and locations.

3.5 Revisions to Design Drawings and Specifications

Revisions are addressed in Section 9.3

3.6 Fast-Track Project Delivery

When it is required that a project be bid before the requirements of Section 3.1 can be met, the Owner may provide sufficient information in the form of scope, drawings, weights, outline specifications, and other descriptive data to enable the fabricator and erector to prepare a knowledgeable bid. Construction shall not commence until drawings are issued for construction, any adjustments to the bid is made and written notice to proceed is given by the Owner.

4.2.4 Legibility of Drawings

Drawings shall be clearly legible and drawn to an identifiable scale that is appropriate to clearly convey the information, but not less than 1/8” to the foot, unless a smaller scale is approved by the Owner’s representative.

4.4 Review of Shop Drawings

Shop drawings shall be made by the Contractor and shall be submitted for review. The architect and engineer will endeavor to complete their review of shop drawing submittals within 14 days of engineer's receipt of submittals for those shop drawings deemed critical; other shop drawings, 28 days. Shop drawings shall be returned noted: "No exceptions noted," or "Exceptions noted," or "Exceptions noted, revise and resubmit." Fabrication of material prior to the receipt of shop drawings for that material noted "No exceptions noted" or "Exceptions noted" shall be at the Contractor's risk.

4.4.1 Review of shop drawings does not relieve the Contractor of the responsibility for accuracy of detail dimensions; the general fit-up of parts to be assembled in the field; the ability to erect the material; the adequacy of any members or connections designed by the Contractor; or the Contractor's safety measures.

4.4.2 Any notations made on the shop drawings or answers to a Request For Information (RFI) do not authorize additional compensation for the Contractor without the issuance of a formal change order.

4.5 Fabrication and/or Erection Drawings Not Furnished by the Fabricator

Fabrication and erection drawings shall be made by the Fabricator or his subcontractor and shall be the responsibility of the Fabricator.

9.3.1 Revisions to the structural steel requirements are made by issuance of new documents, reissuance of existing documents, answers to RFIs, or by annotation of shop or erection drawings.

9.3.2 A revision to the contract price is made by formal change order.

END OF SECTION

SECTION 053000 - METAL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Metal Deck work shall be performed by or under the Contractor of Section 051200, Structural Steel, and as specified in Section 051200, with the additional requirements herein.

B. Section includes all labor, materials, equipment, special tools and services to complete Metal Deck Work required for the Project, as herein specified, and as indicated on the Drawings, including but not limited to:

1. The extent of metal decking, including basic layout and type of deck units is indicated on the Drawings.
2. Performance requirements.
3. All floor decks.
4. All roof decks.
5. All fasteners and accessory items required to make a complete installation.
6. Detailing of metal deck and accessories.
7. Installation of all metal deck and accessories including roof sump pans and reinforcing for all openings up to but not exceeding 12 inches by 12 inches.
8. Repair of deck finishes.

C. Metal deck serves other functions in addition to resisting directly applied loads. The manufacturer shall review the use, details and method of installation of his product as indicated and shall disclose to the Owner's representative any and all deviations from his recommended use and method of installation and shall also make recommendations for the use and method of installation of his product to achieve the intended purpose and result. Such disclosures shall be made within the time stipulated for the submission of shop drawings.

D. Related Sections:

1. Section 033000 - Cast-in-Place Concrete.
2. Section 051200 - Structural Steel
3. Section 055000 - Metal Fabrications.
4. Roofing and Insulation.

1.3 REFERENCES

A. Comply with the provisions of the following codes, specifications and standards; use the latest edition unless date is indicated. Modifications in this specification, when in conflict with the referenced codes, specifications and standards, shall take precedence.

1. "Kentucky Building Code" (KBC).
2. American Iron and Steel Institute, AISI S100-16: "North American Specification for the Design of Cold-Formed Steel Structural Members", October 2016.
3. American Welding Society (AWS) D1.1/D1.1M 2010: "Structural Welding Code - Steel".
4. AWS D1.3/D1.3M 2008: "Structural Welding Code - Sheet Steel".

5. Steel Deck Institute (SDI), ANSI/SDI C-2017: "Standard for Composite Steel Floor Deck – Slabs".
6. ANSI/SDI T-CD-2017: "Test Standard for Composite Steel Deck – Slabs".
7. ANSI/SDI RD-2017: "Standard for Steel Roof Deck".
8. ANSI/SDI NC-2017: "Standard for Non-Composite Steel Floor Deck".
9. ANSI/SDI QA/QC-2017: "Standard for Quality Control and Quality Assurance for Installation of Steel Deck".
10. SDI: "Diaphragm Design Manual, Fourth Edition" - DDM04, September 2015.
11. SDI: "Floor Deck Design Manual First Edition" - FDDM, March 2014.
12. SDI: "Roof Deck Design Manual First Edition" - RDDM, May 2013.
13. SDI: "Manual of Construction with Steel Deck" - MOC3, October 2016.
14. SDI: "Standard Practice Details" - SPD2, May 2001.
15. SDI: "Code of Standard Practice" - COSP-2017, May 2017, as modified herein.
16. International Code Council Evaluation Service (ICC-ES) AC43: "Acceptance Criteria for Steel Deck Roof and Floor Systems".
17. Factory Mutual (FM) Class I Construction (roof deck).
18. Underwriters Laboratories (UL) Online Certifications Directory – Fire Resistance Ratings, www.UL.com.
19. OSHA Regulations, current.

1.4 QUALIFICATIONS

A. Deck manufacturer shall be a member of the Steel Deck Institute and shall have an established quality control program with current auditing by an approved inspection agency in conformance with Chapter 17 of the Building Code. Failure to meet these qualifications will require additional inspections prescribed in Building Code Chapter 17 to be performed by the Owner's inspection agency at the Contractor's expense.

B. Deck detailer and deck supplier shall be approved by the deck manufacturer.

1.5 SUBMITTALS

A. Submit for record evidence of deck manufacturer's qualifications.

B. Submit for record evidence of deck manufacturer's quality control programs, procedures and certifications showing conformance with Chapter 17 of the Building Code.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Submit detailed drawings, include:

1. Unit dimensions, section properties and finish of all types of deck.
2. Drawings to scale indicating layout and types of deck panels, supplementary framing, reinforcement, cut openings, accessories, and sequence of installation.
3. Type and location of welds and other fasteners, and anchorage details.
4. Details of accessories, pour stops, closure strips, plates, and their attachment.
5. Primer paint and color where painted, or surfaces treated for fireproofing, with extent shown on plan.

E. Prior to fabrication, submit for record two copies of manufacturer's evaluation report (ESR), product data, load and diaphragm capacities, specifications, and installation instructions for each type of decking, surface treatment, finish, fasteners and accessories showing compliance

with all requirements of the specifications. Indicate by transmittal form that copies of all applicable instructions have been provided to steel fabricator and erector.

F. Submit for record galvanizing repair and touch up paint product data.

G. Upon request, submit samples for review and acceptance by the Owner's representative. Samples may be used for bond tests of subsequent coatings.

H. Submittals for record, informational submittals, compliance reports and inspection reports will not be reviewed or returned.

1.6 QUALITY CONTROL

A. The Contractor is responsible for and shall perform quality control, inspection, and testing of all metal deck work as required by the Contract Documents, referenced codes, specifications and standards. The Contractor shall reject and replace work that is not in conformance.

B. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure". All welding shall be performed by operators who are qualified for the types of welds used. Verify each operator's qualifications with Owner's inspector prior to using in production.

C. Qualify mechanical fasteners and installation processes in accordance with manufacturer's engineering reports and code recognized approval procedure. Installers shall be certified by the manufacturer or an independent organization. Verify each installer's qualifications with the Owner's inspector prior to using in production.

D. Decking in place is subject to inspection and testing. Expense of removing and replacing portions of decking for testing purposes will be borne by Owner if satisfactory; expense shall be paid by Contractor if unsatisfactory. Remove defective work and replace with new acceptable work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Do not bend or mar deck. Protect deck and packaged materials from corrosion and deterioration. Store off ground and pitched to drain off water. Cover deck with waterproof covering and ventilate.

B. Do not handle or store deck bundles on the structure in a manner that might cause distortion or damage to the deck or the supporting structures. Repair or replace damaged materials or structures as directed. Bent and damaged deck will be rejected.

C. Deliver welding electrodes to job in unbroken packages bearing name of manufacturer. Special handling for electrodes is required per AWS. Provide and use an oven for electrodes requiring continuous drying prior to use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Metal deck serves other functions in addition to resisting directly applied gravity loads. Metal decks are horizontal shear diaphragms that provide local bracing and transfer horizontal loads as part of the overall lateral force resisting system of the structure. The deck must be fastened at regular intervals to all supporting steel and be capable of these functions.

1. Floor metal deck is required to brace the compression flanges of all supporting members during construction, particularly under the load of the floor concrete prior to the concrete setting up.
2. Floor composite metal deck must bond with the concrete floor to develop a composite slab, and is part of the composite framing system of the supporting steel and concrete.
3. Roof metal deck is required to permanently brace the compression flanges of all supporting members, including miscellaneous framing, and act as a shear diaphragm as an essential part of the lateral force resisting system of the structure.

B. Provide deck capable of supporting construction loads, including wet concrete, if applicable, without shoring. Construction loading shall be 20 psf live load or 150 pound/foot concentrated load (see SDI for loading diagrams) in addition to wet weight of concrete plus 1" deflection added concrete.

C. Compute properties of deck sections based on effective design width as limited by AISI Specifications. All data shall be derived from tests certified by an independent testing agency.

D. Provide decking tested and listed in the UL Fire Resistance Directory for specific UL designs indicated on the Architectural Documents. Assemblies shall provide a 2-hour floor rating and a 2-hour roof rating, unless noted otherwise. Units for those assemblies shall bear the UL label.

E. Provide roof decking tested and complying with specified Factory Mutual requirements. Units shall be installed and fastened to meet FM approval.

F. Provide and fasten deck capable of supporting a diaphragm load as noted on the drawings, but not less than 280 pounds per linear foot, working stress load. Apply manufacturer's recommended safety factor, but not less than SF = 2.5. Space attachments no farther apart than the minimum attachments indicated on the drawings and specified herein.

G. Composite deck: Design and fabricate deck with the combined steel deck and concrete section capable of supporting a minimum superimposed live load of 200 psf, working stress load (ignore strength of any concrete reinforcing steel).

H. Roof deck: Design and fabricate deck capable of supporting total dead and live loads of 100 psf. Deflection shall not exceed 1/360 of the span under a live load of 25 psf. Anchor roof deck units to resist net uplift of 30 psf, working stress loads, FM Class I requirements, or as required by the contract documents, whichever is greater.

I. Deck shall have wide ribs suitable for shear stud placement where studs are required. The configuration of the metal deck shall allow studs to develop the full shear value for the particular weights of the concrete as listed in the AISC Specifications, latest edition. The Contractor shall provide written verification of the stud values with a specific deck type and stud spacing.

J. Accessories for a complete installation, including:

1. Provide continuous sheet metal closures, screeds and pour stops at all slab openings, slab edges and deck ends without gaps or voids, of adequate thickness to support concrete and construction loads without distortion.
2. Provide continuous sheet metal plates at all ridges, valleys, change of roof deck direction and areas where roof deck is not nested, lapped or interlocked.
3. Provide roof sump pans for all roof drains.

2.2 MANUFACTURERS

A. Manufacturer of steel deck products shall be a current member of the Steel Deck Institute. Manufacturers may include:

1. Canam.
2. Cordeck.
3. DACS, Inc.
4. Epic Metals Corp.
5. Gooder-Henrichsen Co.
6. Marlyn Steel Decks, Inc.
7. Miami Metal Deck.
8. New Millennium Building Systems.
9. OEG Building Materials.
10. Roof Deck Inc.
11. Sloan Supply Company, Inc.
12. Tri-State Decking, Inc.
13. Valley Joist, Div. Ebsco Industries, Inc.
14. Vulcraft Group, Nucor Corporation.

2.3 MATERIALS

A. Steel for metal deck units and accessories: ASTM A653, SQ33 or higher. Conform to AISI Specification for Design of Cold-Formed Steel Structural Members.

B. Miscellaneous steel shapes: ASTM A 36.

C. Shop finish: ASTM A 924, hot dip galvanizing.

D. Galvanizing repair: Zinc rich galvanize repair compound containing 90% minimum zinc by weight in the dried film. Comply with DOD-P-21035 or The Society for Protective Coatings, Paint Specifications No. 20 (SSPC-PS 20).

E. Welding materials: comply with AWS D1.1 and D1.3.

F. Deck fasteners, subject to compliance with all requirements of the drawings, specifications, and manufacturer:

1. All deck shall be fastened to the supporting steel by either welds, screws, or powder or air actuated pin fasteners. All fasteners must be recognized by the Steel Deck Institute, the ICC-ES International Code Council Evaluation Service, Factory Mutual and Underwriters Laboratory.
2. Fastener spacing indicated on the drawings or in this specification is based on welding to steel supports. Where manufactured fasteners are used, fastener spacing may need to be reduced and is to be designed by the Contractor's engineer and submitted for review.
3. The following manufacturers supply products that generally comply with these requirements:
    a. HILTI Corporation, PO Box 21148, Tulsa, OK, 74121.
    b. ITW Buildex, 1349 West Bryn Mawr Ave., Itasca, Illinois 60143.
    c. PNEUTEK, Inc., 17 Friars Drive, Hudson, NH, 03051.
    d. Simpson Strong-Tie®, 5956 W Las Positias Blvd., Pleasanton CA, 94588.
4. Powder actuated or pneumatic fasteners shall be a minimum of 0.157" diameter. Screws to supports shall be minimum #12. Fasteners shall be zinc coated or galvanized.

2.4 FABRICATION

A. Provide all deck of each type from a single manufacturer.

B. Supply deck units in lengths for 3 or more spans on 4 or more supports, where possible, with interlocking or nested side laps. Where ends are lapped, detail fastening to penetrate through all adjacent sheets and secure deck to supporting steel, especially at 4 corner laps.

C. Deck to receive concrete shall be vented or formed with punched hanger slots in each rib at a maximum of 18" o.c.

D. Minimum thickness of material as fabricated shall be within 5% of the design thickness.

E. Deck gage noted is minimum thickness and may have to be increased based on design considering design loads, steel strength, concrete slab thickness, and span variations. Each deck sheet shall be clearly marked as to location if deck gage or strength varies on the structure.

F. Composite floor deck: G60 galvanized units with depth and minimum thickness as shown on the drawings and as required by design, but not thinner than 20 gage.

G. Roof deck: G90 galvanized units with depth and minimum thickness as shown on the drawings and as required by design, but not thinner than 20 gage. 1½" deep units to be wide rib, type B deck. 3" deep units to be type N. Provide deck configurations complying with SDI roof deck requirements, and Factory Mutual requirements for Type 1 construction. Top surfaces shall not have stiffening ribs.

H. Roof sump pans: 14 gage minimum thickness, galvanized sheet steel with level bottoms, sloped sides, recessed 1½" below deck surface. Size to receive roof drains, with bearing flanges not less than 3" wide. Cut holes for drains in the field.

I. Sheet metal plate: closures, screeds and pour stops, not thinner than 18 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installer shall examine the area and conditions under which metal decking is to be installed.

B. Notify Owner's representative in writing of conditions detrimental to proper and timely completion of the work.

C. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck units and accessories in accordance with manufacturer's recommendations and final reviewed shop drawings, referenced standards and as specified herein.

1. Place deck units in straight alignment, flat and square without warp or excessive deflection, and adjust to final position with proper end bearing on supports before permanently fastening.
2. Place deck units as shown on reviewed installation drawings.
3. Do not stretch or contract side lap interlocks.
4. Fasten as work progresses, do not leave material unsecured.
5. Coordinate with the manufacturer and structural steel erector in sizing and locating decking bundles to prevent overloading structural members.
6. Do not use deck units for storage or working platforms until permanently secured. Do not overload deck in any case.

B. Provide complete, continuous coverage of entire floor and roof areas without gaps or voids other than specifically indicated openings. Include pour stops and other closures to form concrete at edges, openings, and as needed to contain concrete fill without leaks or migrations.

1. Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking.
2. Provide neat, square and trim cuts.
3. Cut openings in deck true to dimensions using metal saws, drills, or cutting torch.
4. Do not use cutting torch where decking is to be permanently exposed to view.
5. Where concrete or other fill is to be placed on deck, seal joints and gaps wider than 1/8" with sheet steel or tape.

C. Attachment of deck.

1. Attachment to supports shall be with fusion welds (puddle welds) with a diameter of 5/8" minimum; or an elongated weld of 3/8" minimum width and ¾" minimum length; or an approved mechanical fastener.
2. Mechanically fasten side laps between supports.
3. Fasten accessories to steel supports at 12" o.c. and to deck at 6" o.c.

D. Welds shall comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work. Weld metal shall penetrate all layers of deck material at end laps and have adequate fusion to the supporting members.

E. Mechanical fasteners to steel supporting members shall be ICC-ES approved with current ESR and submitted for review prior to use. The Contractor shall arrange for a representative of the manufacturer to provide onsite installation training for their products. Submit documentation of training of personnel prior to performing such work. Provide copy to the Owner's inspector.

F. Avoid concentrated loads and impact loads during erection and construction. Plank the deck in all traffic areas to prevent damage to units.

G. Metal deck to receive spray-on finish, insulation, or fireproofing (see architectural contract documents) shall be cleaned of all grease, mill oil, paraffin, dirt, salt and other contaminants which would impair adhesion. All required cleaning shall be done prior to metal deck installation using a cleaning method that is compatible with finish application.

3.3 INSTALLATION, COMPOSITE DECK

A. Installed deck shall be suitable for installation of shear studs with 1" minimum lateral concrete cover typically, and 2" lateral concrete cover at deck mid-height in the load direction. Coordinate installation of deck with installer of shear studs. Shear stud installer shall inspect deck installation.

B. Provide minimum 2" bearing over steel supports and install deck with butted joints, maximum 1/8" gap and with flutes aligned.

C. Bottoms of flutes shall be in full, continuous contact with steel supports. Flatten or remove embossings or ribs as needed to achieve this condition.

D. Attach composite deck to all supports at 12" o.c. Mechanically fasten side laps with #10 screws or button punch, space not to exceed 36" o.c.

3.4 INSTALLATION, ROOF DECK

A. Provide a minimum of 2" bearing and lap ends not less than 2". Do not extend bottom sheet past the support.

B. Minimum attachment.

1. Attach 3" roof deck at 8" o.c. to all supports at ends, end laps and intermediate supports. Attach at 12" o.c. maximum at all edges and where not perpendicular to deck span. Secure deck to each supporting member in ribs in which side laps occur.
2. Attach 1½" roof deck to all supports at 6" o.c. at all ends and end laps. Attach at 12" o.c. at all intermediate supports, edges and where not perpendicular to deck span. Secure deck to each supporting member in ribs in which side laps occur.
3. Mechanically fasten side laps with minimum #10 screws, space not to exceed 24" o.c.
4. Fasteners may need to be larger and/or spaced closer for F.M. and U.L. ratings, diaphragm loading specified, or other requirements. Contractor shall verify fasteners and spacing with manufacturer for the specific deck product and show on the installation drawings.

C. Reinforce deck at openings.

1. Reinforce deck at openings and penetrations with dimensions less than 12" with minimum 18 gage galvanized steel sheet at least 12" wider and longer than the opening. Fusion weld reinforcement to the top of deck at each corner and 6" o.c. along each side.
2. Reinforcing may be omitted for penetrations 4" and smaller that fit between deck ribs.
3. Where deck penetration exceeds 12", frame the opening with a welded angle frame or structural members spanning between joists or beams.
4. Where deck opening or penetration is larger than 12" and less than 24", as an alternate to framed openings, if acceptable to the Owner's engineer, use a 1-1/2 x 1-1/2 x ¼" steel angle on the underside of deck at right angles to ribs, each side of the opening. Extend angles 3 ribs beyond each side of opening and weld deck to angle in each rib. Reinforce opening sides parallel to ribs with 12" wide, 18 gage galvanized steel sheet, 12" longer than opening, each side, placed on top of deck, weld at each corner and 6" o.c. along each side. Side reinforcing may be omitted when a roof sump pan is to be installed over opening.
5. Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work shown.

D. Place roof sump pans over openings provided in roof decking and weld to top of deck at each corner, at each deck flute and not more than 6" o.c. Cut opening in roof sump bottom to accommodate drain size.

E. Provide continuous sheet metal plates at all ridges, valleys, change of roof deck direction and areas where roof deck is not nested, lapped or interlocked. Attach directly to the steel deck at 6" o.c. each side as a finished surface for the application of insulation and roofing.

3.5 INSPECTION

A. Contractor's inspector shall inspect all metal deck work, fasteners and welds as part of the required quality control. Inspect as work proceeds and areas are completed, but ahead of concrete or roof placement. Confirm in reports:

1. Proper material is installed properly, including gage of material and, if gage varies, at correct locations on the structure.
2. Welding qualifications and fastener certifications for deck installers.
3. All (100%) deck welds and mechanical fasteners are installed and inspected, including layout, spacing, size and quality, per the Structural Drawings and project requirements.

4. Galvanized finish is repaired.

B. Owner's inspector shall review Contractor's inspections and verify the installed deck work.

3.6 FINISH REPAIR AND CLEANING

A. Repair galvanized finish on all galvanized steel roof deck, and any deck with exterior exposure, by field coating all damaged and abraded areas with galvanizing repair compound. After decking installation and ahead of roofing, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members. Touch-up surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

B. Following erection, clean all steel deck of mud and dirt accumulated during erection. Thoroughly clean and remove dirt, debris, oil, water, and other foreign material from deck surfaces. Clean composite deck with detergent to remove oil and slick sports that would prevent concrete from bonding. Leave ready for concrete fill, roofing, painting or fireproofing.

END OF SECTION

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For the following, including installation drawings:

1. Cold-formed steel framing materials.
2. Exterior non-load-bearing wall framing.
3. Vertical deflection clips.
4. Single deflection track.
5. Drift clips.
6. Soffit framing.
7. Post-installed anchors.
8. Power-actuated anchors.
9. Sill sealer gasket.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop and Installation Drawings: Project specific.

1. Show detail, length and location of all light gage materials, including any subassemblies to be shop fabricated. Show all welds whether shop or field and indicate all connections to steel frame, concrete and masonry portions of the work.

    a. Show schematic framing elevations indicating stud spacing, stud gage, double or multiple studs, slip joints, bracing and bridging.
    b. Indicate number and size of fasteners and/or size and length of weld.
    c. Include color code identification for gage of members.
    d. For prefabricated framing (if any), show individual panel drawings for each condition including configuration, dimensions, materials, attachments and panel locations.

2. Manufacturer's Certification:

    a. Certify compliance with structural criteria. Published load tables and literature are usually acceptable.

3. Mill Certificates: Submit upon request only.
4. Design Calculations and Shop Drawing Preparation: For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer registered in the State responsible for their preparation. Shop drawings shall also bear the engineer’s signature and seal.
5. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
6. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

D. Delegated Design Submittal: For cold-formed steel framing. Include calculations stamped and signed by qualified professional engineer.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Research Reports:

1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Reference Standards:

1. Specification for the Design of Cold-Formed Steel Structural Members, 2001 Edition, by the American Iron and Steel Institute.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

C. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

D. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, the Steel Stud Manufacturers Association, or the Supreme Steel Framing System Association.

E. 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."

F. Codes and References to be complied with:

1. “Kentucky Building Code”.
2. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
3. ASTM A 1003 - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
4. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
5. ASTM C 955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
6. ASTM C 1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
7. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
8. AISI - Standard for Cold-Formed Steel Framing General Provisions.
9. AISI - North American Specification (NASPEC) for the Design of Cold-Formed Steel Structural Members - 2001, including 2004 Supplement..
10. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
11. AWS D1.3 "Structural Welding Code - Sheet Steel."

G. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

H. 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 cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ClarkDietrich.
2. MBA Building Supplies.
3. MRI Steel Framing, LLC.
4. Marino\WARE.
5. Mill Steel Framing; Mill Steel Company.
6. Steel Network, Inc. (The).
7. Telling Industries.
8. United Metal Products, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

    a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 (Metal Panels) and 1/600 (Brick) of the wall height.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

    a. Upward and downward movement of 3/4 inch (19 mm).

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials. Design exterior non-load-bearing wall framing to accommodate load from angle at base of wall and/or window sill supporting curtain wall framing and /or storefront framing. Refer to details on drawings.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S240.

D. Fire-Resistance Ratings: Comply with ASTM E119; 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 acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

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 AISI S240 for conditions indicated.

C. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As required by structural performance.
2. Coating: G90 (Z275).

D. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G90 (Z275).

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING (STL STUD-1)

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Minimum 16 ga., 54 mils.
2. Minimum Flange Width: 2 inches (51 mm).
3. Section Properties: As required by structural performance.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.
2. Flange Width: 1-1/4 inches (32 mm).

C. Vertical Deflection Clips, Exterior: Manufacturer's standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: Minimum 16 ga., 54 mils.
2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.

E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Minimum 16 ga., 54 mils.
2. Minimum Flange Width: 2 inches (51 mm), minimum.
3. Section Properties: As required by structural performance.

2.6 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Hole-reinforcing plates.
10. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, Grade 55, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC193 ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.

2. Type: Torque-controlled expansion anchor Torque-controlled adhesive anchor or adhesive anchor.
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M MIL-P-21035B or SSPC-Paint 20.

B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.9 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing 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.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated on Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to bypassing and infill studs as designed and anchor to building structure.
4. Connect drift clips to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Installation Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on Installation Drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

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. Steel framing and supports for operable partitions.
2. Steel framing and supports for overhead doors.
3. Steel tube reinforcement for low partitions.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Elevator machine beams**,** hoist beams, and divider beams.
7. Steel shapes for supporting elevator door sills.
8. Shelf angles.
9. Metal ladders.
10. Ladder safety cages.
11. Elevator pit sump covers.
12. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.
13. Metal bollards.
14. Loose bearing and leveling plates for applications where they are not specified in other Sections.
15. Slotted channel frame supports for ceiling hung lights, booms and medical equipment.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Section 051200 "Structural Steel Framing."

1.3 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 metal fabrications that are anchored to or that receive other work. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show project specific fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for operable partitions.
2. Steel framing and supports for overhead doors.
3. Steel tube reinforcement for low partitions.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Elevator machine beams**,** hoist beams, and divider beams.
7. Steel shapes for supporting elevator door sills.
8. Shelf angles.
9. Metal ladders.
10. Ladder safety cages.
11. Elevator pit sump covers.
12. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.
13. Metal bollards.
14. Loose steel lintels.

D. Delegated-Design Submittal: For miscellaneous supports, framing, medical equipment and ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

F. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 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

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design miscellaneous supports, framing, medical equipment and ladders.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

C. Regional Materials: Manufacture products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

D. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

E. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, (interior) and Type 316L (exterior).

F. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 (interior) and Type 316L (exterior).

G. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

H. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

I. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating.

J. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 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 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 2 (A4).

D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: 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/E 488M, conducted by a qualified independent testing agency.

F. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 Interior Painting," and Section 099600 "High-Performance Coatings."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. 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 metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

K. Stainless steel is to be produced in a clean environment completely separated from other steel manufacturing areas to avoid cross contamination of metal.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions and overhead doors from continuous steel members of sizes indicated with attached bearing plates, anchors, and braces as recommended by the product's manufacturer and as designed by the delegated design engineer. Drill or punch bottom flanges of members to receive anchor bolts and hanger rods as required by the product manufacturer; locate holes where indicated on Shop Drawings.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with zinc-rich primer or primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize and prime shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with zinc-rich primer or primer specified in Section 099600 "High-Performance Coatings."

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS (MET FAB-1)

A. General:

1. Comply with ANSI A14.3**,** except for elevator pit ladders.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) steel flat bars, with eased edges.
2. Rungs: 3/4-inch- (19-mm-) diameter steel bars.
3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
4. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
5. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch (12 mm) in least dimension.
6. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
7. Galvanize ladders, including brackets.

2.9 LADDER SAFETY CAGES

A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch (4.8-by-38-mm) flat bars secured to each hoop.
4. Galvanize ladder safety cages, including brackets and fasteners.

2.10 ELEVATOR PIT SUMP COVERS

A. Fabricate from 3/16-inch (4.8-mm) abrasive-surface floor plate with four 1-inch- (25-mm-) diameter holes for water drainage and for lifting.

B. Provide steel angle supports as indicated.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize and prime exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with zinc-rich primer or primer specified in Section 099600 "High-Performance Coatings."

2.12 METAL BOLLARDS (MET FAB-2)

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate.

B. Fabricate bollards with 3/8-inch- (9.5-mm-) thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch (19-mm) anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Prime bollards with zinc-rich primer and provide High-Performance Coating in Safety Yellow.

2.13 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc-rich primer or primer specified in Section 099600 "High-Performance Coatings."

2.14 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer or primer specified in Section 099600 "High-Performance Coatings."

2.15 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.16 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.17 STEEL AND IRON FINISHES

A. 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. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer or primers specified in Section 099113 "Exterior Painting" or primers specified in Section 099123 "Interior Painting" unless zinc-rich primer or primers specified in Section 099600 "High-Performance Coatings" are indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.18 SUSPENDED EQUIPMENT SUPPORTS AND TRACK:

A. Ceiling mounted, suspended equipment, medical related or otherwise, shall be "Unistrut" slotted channel shape P1001 minimum or as required to comply with equipment manufacturer’s details, loads, and deflection limitations. The support system, including fastening to superstructure and any miscellaneous steel items required shall be engineered by Unistrut. The magnitude and

locations of loads shall be coordinated with the manufacturer of the suspended equipment. Engineered sealed shop drawings shall be submitted. Tracks shall be installed per equipment manufacturers printed instructions and shall conform to the tolerances specified by the equipment manufacturer. See structural drawings for additional Unistrut support system requirements.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. 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.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions and overhead doors securely to, and rigidly brace from, building structure.

3.3 INSTALLATION OF SHELF ANGLES

A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.4 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.5 INSTALLATION OF ELEVATOR PIT SUMP COVERS

A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.6 INSTALLING METAL BOLLARDS

A. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.

3.7 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.8 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the 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 (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting." and Section 099123 "Interior Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 055113 - METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with concrete-filled treads.
2. Steel tube railings and guards attached to metal stairs.
3. Steel tube handrails attached to walls adjacent to metal stairs.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Section 055213 "Pipe and Tube Railings" for pipe and tube railings.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs, railings, and guards.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, blocking for attachment of wall-mounted handrails, and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Shop primer products.
2. Handrail wall brackets.
3. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include project specific plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

D. Delegated Design Submittal: For stairs, railings and guards, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. 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."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.

3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

    a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design stairs, railings and guards, including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, 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. (0.73 kN/m) applied in any direction.
    b. Concentrated load of 200 lbf (0.89 kN) 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 (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
    b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

    a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS (MET STAIR-1, MET RAIL 2)

A. Metal Surfaces: 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.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

C. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed) or ASTM A513/A513M.

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

D. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

2.3 FASTENERS

A. General: Provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5 where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

A. Handrail Wall Brackets: Steel

B. Welding Electrodes: Comply with AWS requirements.

C. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for interior or exterior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings and guards, 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.

B. Assemble stairs, railings, and guards in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
2. 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.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that will be exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of steel plates or steel channels or steel rectangular tubes as indicated on Drawings.

    a. Stringer Size: As required to comply with "Performance Requirements" Article and as indicated on Drawings.
    b. Provide closures for exposed ends of channel and rectangular tube stringers.
    c. Finish: Shop primed and finish painted.

2. Platforms: Construct of steel plate or steel channel or steel rectangular tube headers and miscellaneous framing members as required to comply with "Performance Requirements" Article and indicated on Drawings.

    a. Provide closures for exposed ends of channel and rectangular tube framing.
    b. Finish: Shop primed and finish painted.

3. Weld stringers to headers; weld framing members to stringers and headers.
4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below.

    a. Locate hanger rods and struts where they do not encroach on required stair width and are 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 Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch (1.7 mm).

1. Steel Sheet, Uncoated: Cold-rolled steel sheet unless otherwise indicated.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
4. Shape metal pans to include nosing integral with riser.
5. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
6. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

    a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: As indicated on Drawings.
2. Picket Infill: As indicated on Drawings, spaced to prohibit the passage of a 4-inch (100-mm) diameter sphere.

C. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

    a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint as shown in NAAMM AMP 521.

D. Form changes in direction of railings and guards as follows:

1. As detailed.

E. 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.

F. Close exposed ends of railing and guard members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

1. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

H. Connect posts to stair framing by direct welding unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
3. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.

1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. 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.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.

c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

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.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
4. Secure posts, rail ends, and guard ends to building construction as follows:

a. Anchor posts to steel by welding to steel supporting members.
b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as required to comply with performance requirements and as follows:

a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.

3.4 REPAIR

A. Touchup Painting:

1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 055113

SECTION 055119 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal grating stairs and catwalk.
2. Steel railings and guards.

1.2 COORDINATION

A. Coordinate installation of anchorages for metal stairs, railings, guards and catwalk.

1. 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.
2. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Gratings.
2. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.

D. Delegated Design Submittal: For stairs, railings, guards, and catwalk including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

B. Installer Qualifications: Fabricator of products.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design stairs, railings, guards, and catwalk including attachment to building construction.

B. Structural Performance of Stairs and Catwalk: Metal stairs and catwalk withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360.

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, 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. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) 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 (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS (MET FAB-4)

A. Metal Surfaces: 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.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

C. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

D. Steel Wire Rod for Grating Crossbars: ASTM A510/A510M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

E. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

F. Provide galvanized finish for exterior installations and where indicated.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.

E. Post-Installed Anchors: Torque-controlled expansion 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 E488/E488M, conducted by a qualified independent testing agency.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780/A780M.

C. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

2.5 FABRICATION, GENERAL

A. Provide complete stair and catwalk assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms and catwalks on supporting structure.

1. Join components by welding unless otherwise indicated.

2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs, railings, guards and catwalk in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
2. 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.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish # 3 - Partially dressed weld with spatter removed.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that are exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel plates.

a. Stringer Size: As required to comply with "Performance Requirements" Article
b. Finish: Galvanized.

2. Construct platforms and tread supports of steel plate or channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.

a. Provide closures for exposed ends of channel framing.
b. Finish: Galvanized.

3. Weld stringers to headers; weld framing members to stringers and headers.

4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Heavy-Duty Metal Bar-Grating Stairs and Catwalk: 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 steel grating with 1-1/2-by-1/4-inch bearing bars at 13/16 inch o.c. and 3/4-inch-by-1/8-inch crossbars at 4 inches (100 mm) o.c.

D. Risers: Open.

E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.

1. Material and Finish: Steel plate to match finish of other steel items.
2. Fabricate to dimensions and details indicated.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS AND CATWALK

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

C. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #3 - Partially dressed weld with spatter removed as shown in NAAMM AMP 521.

D. Form changes in direction of railings and guards as follows:

1. As detailed.

E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.

1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

F. Close exposed ends of railing and guard members with prefabricated end fittings.

G. Connect posts to stair framing by direct welding unless otherwise indicated.

H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.

2.8 FINISHES

A. Finish metal stairs and catwalk after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. 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.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:

1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL STAIRS AND CATWALK

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs and catwalk to in-place construction.

1. 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 and catwalk. 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.

1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.

a. Clean bottom surface of baseplates.
b. Set steel-stair baseplates on wedges, shims, or leveling nuts.
c. After stairs have been positioned and aligned, tighten anchor bolts.
d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

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.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. 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.
3. Comply with requirements for welding in "Fabrication, General" Article.

F. Attach toeplates to gratings at locations indicated.

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
4. Secure posts, rail ends, and guard ends to building construction as follows:

a. Anchor posts to steel by welding to steel supporting members.
b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

3.4 REPAIR

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055119

SECTION 055213 - PIPE AND TUBE RAILINGS

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. Steel pipe and tube railings.
2. Stainless-steel tube railings. Barrier rail (cane detection)

B. Related Requirements:

1. Section 055112 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.
2. Section 057300 "Decorative Metal Railings" for ornamental railings fabricated from pipes and tubes.

1.3 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Railing brackets.
2. Grout, anchoring cement, and paint products.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include project specific 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 members at intersections.

E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

F. Evaluation Reports: For post-installed anchors, from ICC-ES.

G. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 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 D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 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

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, 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. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) 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 (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C, material surfaces).

2.2 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 (38-mm) clearance from inside face of handrail to finished wall surface.

2.3 STEEL AND IRON (MET RAIL 1)

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.

C. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

D. Plates, Shapes, and Bars: ASTM A 36/A 36M.

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.4 STAINLESS STEEL (MET RAIL 3)

A. Tubing: ASTM A 554, Grade MT 304.

2.5 FASTENERS

A. General: Provide the following:

1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.
2. Stainless-Steel Railings: Type 304 stainless-steel fasteners.

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 otherwise indicated.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

C. Intermediate Coats and Topcoats: Provide products that comply with Section 099600 "High-Performance Coatings."

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. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix

does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

2.7 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 (1 mm) 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 welded 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. Form Changes in Direction as Follows:

1. As detailed.

J. 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.

K. Close exposed ends of railing members with prefabricated end fittings.

L. 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 1/4 inch (6 mm) or less.

M. 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.

N. 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.

O. For railing posts set in concrete, provide steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

2.8 STEEL AND IRON FINISHES

A. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below:

1. Railings Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Other Railings: SSPC-SP 3, "Power Tool Cleaning."

C. 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 primers specified in Section 099600 "High-Performance Coatings" are indicated.

2.9 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines, or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Directional Satin Finish: No. 4.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and 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.

3.2 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 (2 mm in 1 m).
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 (6 mm in 3.5 m).

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.

3.3 RAILING CONNECTIONS

A. 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.

B. 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 (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are 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. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.

C. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

C. Attach railings to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. 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 hollow masonry anchorage, use toggle bolts.
3. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.

3.6 ADJUSTING AND CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

3.7 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 055213

SECTION 05 5600

CASTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, and equipment required to install castings as shown on the Drawings and specified herein. Included in this section are manhole covers, steps, valve boxes, hatch covers, and commemorative plaques.

1.02 RELATED WORK NOT INCLUDED

A. Concrete work is included in Division 03.

B. Masonry work is included in Division 04.

C. Surface preparation and finishing of castings is included in Division 09.

D. Floor drains and roof drains are included in Division 15.

E. Special cast valves are included in Division 15.

1.03 SUBMITTALS

A. The CONTRACTOR shall submit to the ENGINEER, in accordance with Division 01, copies of construction details of castings proposed for use.

PART 2 MATERIALS

2.01 GENERAL

A. All castings shall be gray iron, conforming to the requirements of the ASTM Standards, Designation A 48-83, Class 35-B for manhole casting and Class 20 for valve boxes.

2.02 MANHOLE CASTINGS

A. Frames and Covers

1. Manhole castings shall consist of cast iron frames and 22-3/4 inch diameter covers. All manhole castings shall be designed for H-20 traffic loading. The frame shall be at least 7 inches high overall. Manhole covers must set neatly in the frame, with contact surfaces machined smooth for even bearing. The top of the cover shall be flush with the frame edge. The top of the cover shall have sufficient corrugations to prevent slipperiness and be marked in large letters "SANITARY SEWER" or "STORM SEWER" as applies. Covers shall have one or 2 pick holes only, about 1-1/2 inches wide and 1/2-inch deep with 3/8-inch square undercut at rear and

3/4-inch square undercut on sides. Covers on sanitary sewer manholes must not be perforated.

B. Steps

1. Polypropylene plastic encapsulated steel manhole steps shall be of patterns shown on the detail Drawings, and have corrugated treads. In case of need for nonprotruding steps, shop drawings of special inset cast iron steps shall be reviewed by and be acceptable to the ENGINEER prior to use.

2. It is intended that the polypropylene plastic encapsulated steel step be M.A. Industries PS-1, PS-1PF, or equal.

2.03 VALVE BOXES

A. Slide Type for Iron Body Gate Valves

1. Valve boxes for sizes through 12-inch valves shall be the cast iron slide type, without screw, of sufficient length to allow for 30 inches of cover over the top of the pipe. The inner section shall have a minimum inside diameter of 5-1/4 inches with a hood type base that will cover the packing gland on valves through 12 inches in size (minimum of 8 inches inside diameter). The base of the top section shall be flanged at least 1-1/4 inches. The caps shall be circular with a corrugated surface and have pick holes in the periphery and be marked "Water," "Gas," "Sewer," or "Air" according to use. The valve boxes shall be Tyler Pipe/Utilities Division, 6855 Series, or equal.

2. For vertical valves larger than 12-inch size, provide Tyler Pipe/Utilities Division Series 6865 with No. 8 base, or equal.

3. Valve boxes for valves in the horizontal position shall be cast iron Tyler Pipe/Series 6855 or equal, with a base that is sized to allow covering of the bevel gear case and centering of the operating nut in the valve box.

PART 3 EXECUTION

3.01 INSTALLATION OF CASTINGS

A. Installation In or On Structures

1. The installation of castings is generally covered under specifications for pipe work and manholes. Castings shall be leveled, plumbed, and secured before pouring concrete or attaching to masonry with solid, watertight, cement mortar joints.

B. Installation on Buried Valves

1. Valve box construction shall consist of the approved manufactured box and accessories. Line pipe shall not be accepted for use as valve boxes.

2. Mechanically tamp backfill, or backfill with crushed rock to the bottom of the packing gland of the operating nut. Install valve box base centered over operating nut.

3. Install valve box shafts, of the required height, and top section to proposed top elevation. Mechanically tamp backfill around box or backfill with crushed rock.

4. Place reinforced concrete collar around top section when shown on the Drawings.

5. Furnishing and installation of the valve box and accessories, including the concrete valve box collar, shall be included in the price bid for furnishing and installation of the valve.

END OF SECTION

***

SECTION 057100 - DECORATIVE METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes decorative metal stairs.

B. Related Requirements:

1. Section 055113 "Metal Pan Stairs."

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs.

1. 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.
2. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Shop primer products.
2. Precast terrazzo treads.
3. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.

D. Samples for Verification: For each type and finish of tread.

E. Delegated Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the State in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, and railings, including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
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/720 or 1/4 inch (6.4 mm), whichever is less.

2.2 METALS (DEC STAIR-1)

A. Metal Surfaces: 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.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Tubing: ASTM A500/A500M (cold formed) or ASTM A513/A513M.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

E. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, either commercial steel, Type B, or structural steel, Grade 30 (Grade 205), unless another grade is required by design loads.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

D. Post-Installed Anchors: Torque-controlled expansion 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 E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

C. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

2.5 PRECAST TERRAZZO TREADS

A. Precast Terrazzo Stair Treads: Epoxy terrazzo units cast in maximum lengths possible. Comply with manufacturer's written instructions for fabricating precast terrazzo units in sizes and profiles indicated.

1. Epoxy Resin Matrix: Manufacturer's standard, recommended for use indicated.
2. Aggregates: Comply with NTMA gradation standards for mix indicated, and containing no deleterious or foreign matter.

    a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
    b. 24-Hour Absorption Rate: Less than 0.75 percent.
    c. Dust Content: Less than 1.0 percent by weight.

3. Reinforcement: ASTM A615/A615M, Grade 60 (Grade 420) bars, as required by unit size, profile, and thickness.
4. Abrasive Inserts: 1/2-inch- (13-mm-) wide, alundum oxide/epoxy mixture.

    a. Provide three inserts, 1/2 inch (13 mm) apart, with first insert located 1 inch (25 mm) from nosing at adjacent stair riser locations.

5. Color: As indicated on Drawings.
6. Finish: Honed.
7. Surface Sealer: Slip and stain-resistant, penetrating sealer that is chemically neutral with pH factor between 7 and 12; does not affect color or physical properties of terrazzo type indicated; is recommend by sealer manufacturer for use with specified terrazzo; and complies with NTMA guide specification for terrazzo type applicable for this Project.

2.6 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.

B. Assemble stairs in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
2. 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.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.

2.7 FABRICATION OF STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of AESS steel tubes and as indicated on Drawings.

a. Stringer Size: As required to comply with "Performance Requirements" Article and As indicated on Drawings.
b. Provide closures for exposed ends of tube stringers.
c. Finish: Shop primed.

2. Platforms: Construct of steel rectangular tube headers and miscellaneous framing members as required to comply with "Performance Requirements" Article and indicated on Drawings.

a. Provide closures for exposed ends of tube framing.
b. Finish: Shop primed.

3. Weld stringers to headers; weld framing members to stringers and headers.

C. Subtreads, Risers, and Subplatforms:

1. Fabricate subtreads and subplatforms of steel plates.
2. Form subtreads, risers, and subplatforms to configurations indicated from of thickness needed to comply with performance requirements, but not less than 0.075 inch (1.9 mm) thick.
3. Weld subtreads to stringers.

    a. Locate welds on top of subtreads where they will be concealed by finished treads.

4. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads.

    a. Weld subplatforms to platform framing.
    b. Locate welds on top of subplatforms where they will be concealed by finished flooring.
    c. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.8 STAIR RAILINGS

A. Comply with applicable requirements in Section 057313 "Glazed Decorative Metal Railings."

1. Connect posts to stair framing by direct welding unless otherwise indicated.

2.9 FINISHES

A. Finish metal stairs after assembly.

B. Steel Shop Prime Finish:

1. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.

    a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLING METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. 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.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

E. 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.
2. 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.
3. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

F. Install precast terrazzo treads according to manufacturer's written instructions.

3.3 REPAIRS

A. Touchup Painting:

1. 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.

a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 057100

SECTION 057300 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior stainless steel decorative railings and swing gates.

B. Related Requirements:

1. Section 055213 "Pipe and Tube Railings" for nonornamental railings fabricated from pipes and tubes.

1.2 COORDINATION AND SCHEDULING

A. 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 items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of decorative metal railings assembled from standard components.
2. Illuminated posts.
3. Stainless steel cable and cable fittings.
4. Fasteners.
5. Post-installed anchors.
6. Nonshrink, nonmetallic grout.
7. Anchoring cement.
8. Metal finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include plans, elevations, sections, and attachment details.

1. For illuminated railings, include wiring diagrams and roughing-in details.

D. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including top rails, posts, and balusters
2. Illuminated posts.
3. Fittings, end caps, and brackets.
4. Welded connections.
5. Cable and cable hardware and connections.
6. Assembled Sample of railing system, made from full-size components, including top rail, illuminated post, and guard infill. Sample need not be full height.

a. Show method of connecting and finishing members at intersections.

F. Delegated Design Submittal: For railings and gates, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For delegated design professional engineer and testing agency.

B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

E. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

F. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

B. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Installer Qualifications: Fabricator of products.

D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups for each form and finish of railing, consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches (600 mm) in length.
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 decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design railings and gates, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, are to 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. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) 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 (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 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: Same metal and finish as supported rails unless otherwise indicated.

2.3 STAINLESS STEEL DECORATIVE RAILINGS (MET RAIL-6)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wagner Companies (The); R&B Wagner, Inc.; Legato Railing System (without panel clips) and with Ultra-tec Cable Railing Assembly with “Invisiware” Fittings or a comparable product by one of the following:

1. C.R. Laurence Co., Inc.; CRH Americas, Inc.
2. Julius Blum & Co., Inc.

B. Source Limitations: Obtain stainless steel decorative railing components from single source from single manufacturer.

C. Pipe: ASTM A312/A312M, Grade TP 316. 1.90” Schedule 40 round stainless steel posts and top rail.

D. Mounting Type: Fascia mount.

E. Castings: ASTM A743/A743M, Grade CF 8M or CF 3M.

F. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 316.

G. Flat Bar: ASTM A666, Type 316.

H. Bars and Shapes: ASTM A276/A276M, Type 316.

I. Illuminated Posts: Provide internal illumination using concealed, internally wired, integrated LED lamps without light leaks. Make provisions for servicing and for concealed connection to electric service.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Wagner Companies (The); R&B Wagner, Inc.; Integrated Lumenpod 30 Post Lighting or a comparable product by one of the following:

a. C.R. Laurence Co., Inc.; CRH Americas, Inc.
b. Julius Blum & Co., Inc.

2. LED Luminaires: Comply with Division 26. Provide Wagner Lumenpost Integrated Driver Enclosures as required.

J. Stainless Steel Cable and Cable Fittings:

1. Cable: 1-by-19 wire cable made from wire complying with ASTM A492, Type 316.
2. Cable Diameter: 1/4 inch (6.4 mm).
3. Cable Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of cable with which they are used.

2.4 SWING GATES

A. Gate Configuration: As indicated on Drawings.

B. Gate Frame Height: As indicated on Drawings.

C. Gate Opening Width: As indicated on Drawings.

D. Infill: Comply with requirements for adjacent fence.

E. Hardware: Provide card reader on gate as indicated on Drawings.

F. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.

G. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use.

1. Function: 01 - Exit only, no trim or blank escutcheon.
2. Mounting Channel: Bent-plate channel formed from 1/8-inch- (3.2-mm-) thick, aluminum plate. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending 1/8 inch (3.2 mm) beyond push pad surface.

2.5 FASTENERS

A. Fastener Materials:

1. Stainless Steel Railing Components: Type 316 stainless steel fasteners.
2. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless steel bolts, ASTM F593 and nuts, ASTM F594.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For stainless steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

C. 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, 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.

2.7 FABRICATION

A. 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.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
2. 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 will be exposed to weather in a manner to exclude water.

1. Provide weep holes where water may accumulate.
2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded or mechanical 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 welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.

I. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings.

1. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
2. 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. As detailed.

K. Bend members in jigs to produce uniform curvature for each 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 hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other Work unless otherwise indicated.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry Work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
2. Coordinate anchorage devices with supporting structure.

O. Stainless Steel Cable Guard Infill: Fabricate cable guard infill assemblies in the shop to field-measured dimensions with fittings machine swaged.

1. Minimize amount of turnbuckle take-up used for dimensional adjustment, so maximum amount is available for tensioning cable.
2. Tag cable assemblies and fittings to identify installation locations and orientations for coordinated installation.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. 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.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Stainless Steel Finishes:

1. Directional Satin Finish: ASTM A480/A480M, No. 4.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.

1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
6. 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 (6 mm in 3 m).

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. 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 (50 mm) beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches (150 mm) of post.

3.3 ANCHORING POSTS

A. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.4 ATTACHING RAILINGS

A. 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.

3.5 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.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. .

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894 and ASTM E935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.

D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.7 CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

3.8 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.

3.9 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.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 057300

SECTION 057310 – DECORATIVE SITE RAILINGS

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. Painted steel handrails
   2. Painted steel guardrails
   3. Wire mesh barrier

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 03 Section 'Miscellaneous Site Concrete’
   3. Division 07 Section ‘Joint Sealants’
   4. Division 32 Section ‘Exterior Planting’

1.3 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. 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.

C. Structural Performance: Railings shall withstand 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. 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. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made by the Contractor. Retesting of products that fail to meet specified requirements shall be done at Contractor's expense.
   1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
   2. Test railings according to ASTM E 894 and ASTM E 935.
   3. Notify Landscape Architect ten (10) days in advance of the dates and times when laboratory mockups will be tested.

1.6 SUSTAINABLE DESIGN SUBMITTALS

A. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.7 ACTION SUBMITTALS

A. Product Data for the following:
   1. Manufacturer's product lines of railings assembled from standard components.
   2. Grout, anchoring cement, and paint products

B. Samples for Initial Selection: For products involving selection of color, texture, or design including mechanical finishes.

C. Samples for Verification: Submit fabricated samples (of sufficient size to fully show construction, materials, and finishes, plus requirements as indicated below) of the following items:
   1. Metal Samples:
      a. Painted Steel
   2. Fabrication: Submit material samples of metals (thickness, weight) indicated for the finished product.
      a. Provide sections of each component member including fittings and brackets. Minimum 6” long sample representing typical fabrication techniques but without finish system (prime and finish paint coats).
      b. Samples to include:
         1) Welded connections.
         2) Fittings and brackets.
   3. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified engineer responsible for their preparation.

E. Shop drawings: Include plans, elevations, sections, details, and attachments to other work.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified for professional engineer or testing agency.

B. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

C. Welding Certificates.

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. Preconstruction Test Reports.

1.9 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for system's 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 structural analysis, preconstruction testing, field testing, and in-service performance.
   1. Do not modify intended aesthetic effects, as judged solely by Landscape Architect, except with Landscape Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Landscape Architect for review.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of railings and are based on the specific system indicated.
   1. Do not modify intended aesthetic effects, as judged solely by Landscape Architect, except with Landscape Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Landscape Architect for review.

D. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.6, "Structural Welding Code – Stainless Steel”
   2. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. 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.

F. 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 mockups for each form and finish of railing consisting of two posts, top rail, interim post, and anchorage system components that are full height and are not less than 24 inches (600 mm) in length.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site.

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.
1. Provide allowance for trimming and fitting at site.

1.11 COORDINATION AND SCHEDULING

A. 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.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.

PART 2 - PRODUCTS

2.1 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: Same metal and finish as supported rails unless otherwise indicated.
1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
3. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.

2.2 STEEL

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 554, Grade MT 316L.

C. Pipe: ASTM A 312/A 312M, Grade TP 316L.

D. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 316L.

E. Bars and Shapes: ASTM A 276, Type 316L. Uncoated, cold rolled steel sheet: ASTM A1008.

2.3 STEEL FINISHES

A. Galvanized Railings:
1. Hot-dip galvanized exterior 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.
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.
6. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
7. 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.
8. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 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.
9. Shop prime uncoated railings with primers specified in Section 099113 "Exterior Painting" unless otherwise indicated.
10. Shop-Painted Finish: Comply with Part 2, detailed herein.

2.4 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. 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.

C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

D. Colors: Color to be selected from manufacturer’s full range. Landscape Architect to approve final color selection.

E. Surface Preparation:
1. All surfaces shall be cleaned according to SSPC-SP1 Solvent Cleaning standards to remove all dirt, oils, and foreign matter.
2. All surfaces shall be uniformly scarified by abrasive blast cleaning all surfaces according to SSPC-SP7 Brush-Off Blast standards. This procedure shall create a profile for the new coating system to adhere to.
3. All surfaces must be clean and dry prior to painting.

2.5 PRIMERS

A. Ferrous Metal Primer (Exterior & Interior) – For Paint Shop Applied on Surfaces Blast Cleaned in the Shop (2.5-3.5 mills). Manufacturers:
   1. Sherwin Williams
   2. Con-Lux
   3. Tnemec

B. Ferrous Metal Primer (Exterior & Interior) – For Paint in the Field - Applied on Bolts, Abraded Areas, Masked Areas, and Field Welds After Power Tool and Solvent Cleaning (2-3). Manufacturers:
   1. Sherwin Williams
   2. Con-Lux
   3. Tnemec

C. Galvanized-Metal Substrates (Exterior) – For Paint applied to Guardrails:
   1. Sherwin Williams
   2. Con-Lux
   3. Tnemec

2.6 EXTERIOR FINISH COATS

A. Ferrous Metal Semi-Gloss Acrylic Urethane Finish: 2 coats over primer (2-3 mills each coat).
   1. First Coat:
      a. Sherwin-Williams; DTM Acrylic Top Coat
      b. Con-Lux, Epolon Rust Inhibitor II.
      c. Tnemec, Series 73 Endura – Shield III.
   2. Second Coat:
      a. Sherwin-Williams, DTM Acrylic Top Coat.
      b. Con-Lux, Acrolon Muti/Mill Series.
      c. Tnemec, Series 72 Endura – Shield III.

B. Exterior Polyurethane-Based Clear Satin Varnish: Factory-formulated polyurethane-based clear varnish.
   1. Sherwin-Williams; Wood Classics Fast Dry Oil Varnish, Satin A66-300 Series.
   2. Benjamin Moore; Benwood Interior Wood Finishes Polyurethane Finished Low Lustre No.435
   3. Coronado; 151-100 Alkyd Clear Satin Varnish.
   4. Dulux Paint; 1902-0000 WoodPride Interior Satin Polyurethane Varnish.
   5. Kelly-Moore; 2050 Kel-Aqua Stain Base.
   6. M.A.B. Paint; Rich Lux Water Based Satin Polyurethane.
   7. Pittsburgh Paints; 77-7 Rez Varnish, Interior Satin Oil Clear.

C. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample paint materials,
   2. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
   3. Testing agency will perform tests for compliance with product requirements.
   4. 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.

2.7 WIRE MESH BARRIER

A. Manufacturer: Subject to compliance with requirements, provide products by the following: Omega II Fence Systems. 1735 St-Elzear Blvd West, Laval, Quebec, Canada H7L 3N6; Phone: 1-800-836-6342; email: customservice@omegatwo.com

B. Post: 2”x2” Powdercoated Steel Post
   1. Height: As shown on drawings.
   2. Color: Signal Black

C. Panel: Omega Architectural Meshwire Panel
   1. Panel Size: As shown on drawings.
   2. Color: Signal Black

2.8 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
   1. Stainless-Steel Components: Type 316 stainless-steel fasteners.
   2. Dissimilar Metals: Type 316 stainless-steel fasteners.

B. Fasteners for Anchoring 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. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated.

D. Anchors, General: 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.

E. Post-Installed Anchors: Torque-controlled expansion anchors or per manufacturer recommendation.

F. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M) or per manufacturer recommendation.

2.9 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

C. Anchoring Cement: Factory-packaged, non-shrink, non-staining, 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 or 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.

2.10 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. Assemble railings in the 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. Use connections that maintain structural value of joined pieces.

C. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

D. 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.

E. Form work true to line and level with accurate angles and surfaces.

F. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

G. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

H. Connections: Fabricate railings with welded connections unless otherwise indicated.

I. 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 welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

J. Mechanical 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.

K. Form changes in direction as detailed in the Drawings.

L. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

M. Close exposed ends of hollow railing members with prefabricated end fittings.

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. 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.

O. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure. Sleeves to match steel of the handrail.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine step assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 PREPARATION

A. Coordinate and furnish anchorages and setting drawings, diagrams, templates, instructions, and directions for installing items having integral anchors that are to be embedded in concrete construction. Coordinate delivery of such items to the Project site.

B. Install sleeves and other elements with attachment fasteners that will be concealed by concrete at time of placement of concrete paving.

3.3 PREPARATION FOR PAINTING

A. Comply with manufacturer’s written instructions and recommendations in “MPI Manual” applicable to substrates and paint systems indicated.

B. All surfaces shall be cleaned according to SSPC-SP1 Solvent Cleaning standards to remove all dirt, oils, and foreign matter.

C. All surfaces shall be uniformly scarified by abrasive blast cleaning all surfaces according to SSPC-SP7 Brush-Off Blast standards. This procedure shall create a profile for the new coating system to adhere to.

D. All surfaces must be clean and dry prior to painting.

E. Remove hardware, covers, plates, and similar items already in place that are removable and 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.

F. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.4 SHOP APPLICATION OF COATING SYSTEMS

A. General:
1. Apply coating in a timely fashion after completion of preparation. Schedule work to apply coating over properly prepared surface before corrosion or salt deposition occur.
2. Follow coating manufacturer’s recommendations for preparation of equipment; mixing, thinning, and pot life of coatings; and application.
3. Do not apply coatings outdoors when air temperature is at less than 50 degrees F or greater than 90 degrees F.
4. Do not apply coatings outdoors during inclement weather such as rain, fog, mist, snow, etc., not to damp or wet surfaces, or when these conditions are imminent.
5. Cease exterior painting when the wind velocity exceeds 10 miles per hour.

B. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual.”
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.

C. Tint undercoats same color as topcoat but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

D. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

E. 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.

3.5 FIELD QUALITY CONTROL - PAINTING

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.6 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 have been 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 (2 mm in 1 m).
   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 (5 mm in 3 m).

C. Corrosion Protection: Coat concealed surfaces of copper alloys that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

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.

3.7 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. 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 (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.8 ANCHORING POSTS

A. Form or core-drill holes not less than 6 inches (152 mm) deep and 1/2 inch (12 mm) 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 non-shrink, non-metallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Cover anchorage joint with flange of same metal as post and as indicated in the Drawings.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Payment for these services will be made by Owner.

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Landscape Architect and will comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of re-placed or additional work with specified requirements.

3.10 CLEANING, PROTECTION AND ADJUSTMENT

A. Clean steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
   1. If necessary, re-polish affected areas to match adjacent finishes.

B. Protection: Protect all work from misuse or damage during construction period with temporary protective coverings approved by ornamental metalwork fabricator. Remove protective covering at the time of Substantial Completion. Work, which is scratched, etched or damaged, may not be accepted by the Landscape Architect, and shall be replaced with acceptable work or, as approved, repaired at no additional cost to Owner.

C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.11 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day’s work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 057310

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

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. Wood blocking and nailers.
2. Plywood backing panels.

B. Related Requirements:

1. Section 061600 "Sheathing".

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 ACTION 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 and net amount of preservative retained.
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 based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.

2. Product Data: For installation adhesives, indicating VOC content.
3. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.

B. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Regional Materials: Manufacture dimension lumber, except treated materials, within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process (WD BLKG-1): Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Cants.

B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.

C. Concealed Boards: 19 percent maximum moisture content of the following species and grades:

1. Mixed southern pine or southern pine, No. 3 grade; SPIB.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening to Metal Framing: ASTM C1002 or ASTM C954, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4).

2.7 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

A. Install where indicated and where required for 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.

3.3 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 miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 061600 - SHEATHING

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. Wall sheathing.
2. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for plywood backing panels.
2. Section 072726 “Fluid-Applied Membrane Air Barriers.”

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION 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 plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
2. Product Data: For installation adhesives, indicating VOC content.

3. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated plywood.
2. Fire-retardant-treated plywood.

B. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WOOD PANEL PRODUCTS

A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

B. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

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 as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat plywood indicated on Drawings.

2.5 WALL SHEATHING (GYP SHTG-1)

A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed; SAINT-GOBAIN; CertainTeed GlasRoc Type X Sheathing.
b. Georgia-Pacific Gypsum LLC; DensGlass Sheathing.
c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond® eXP® Fire-Shield® Sheathing.
d. USG Corporation; Securock.

2. Type and Thickness: Type X, 5/8 inch (15.9 mm) .
3. Size: 48 by 96 inches (1219 by 2438 mm) for vertical installation.

2.6 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 of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Coordinate sheathing board joint treatment with the requirements of the air/vapor/water barrier manufacturer.

PART 3 - EXECUTION

3.1 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. Arrange joints so that pieces do not span between fewer than three support members.

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. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

D. Coordinate 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.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

3.3 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 panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
3. Install panels with a 1/4-inch (6.4-mm) 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, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Coordinate sheathing board joint treatment with the requirements of the air/vapor/water barrier manufacturer.

END OF SECTION 061600

SECTION 064013 – EXTERIOR ARCHITECTURAL WOODWORK

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. Wood cladding for raised garden bed over structure.

B. Related Sections:
   1. Division 03 Section ‘Cast in Place Concrete’
   2. Division 32 Section 'Unit Paving’
   3. Division 32 Section 'Garden Roof Assembly’

1.3 REFERENCE STANDARDS

A. For 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. RIS: Redwood Inspection Service.
   4. SPIB: The Southern Pine Inspection Bureau.

B. For other related assembly materials:
   1. AWS - American Welding Society
      a. AWS D1.1-96: Structural Welding Code--Steel
      b. AWS D1.3-89: Structural Welding Code--Sheet Steel
   2. NAAMM - National Association of Architectural Metal Manufacturers
      a. Metal Finishes Manual for Architectural and Metal Products. 1988.
   3. American Society for Testing and Materials
      a. ASTM A276-96: Specification for Stainless Steel Bars and Shapes
      b. ASTM A666-96: Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
      c. C157-03 Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete
      d. C827-01a Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
      e. ASTM C1107-91a: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
      f. ASTM F593-95: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
      g. ASTM F594-91: Specification for Stainless Steel Nuts
      h. ASTM C920-95, “Specifications for Use of Elastomeric Joint Sealants”

i. ASTM C1021-97, Practice for Laboratories Engaged in Testing of Building Sealants"
j. ASTM C1087-00, "Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems"
k. ASTM C1193-00, "Guide of Use of Joint Sealants"

1.4 SUBMITTALS

A. Certificates/Manufacturer's Data: Submit for approval of Landscape Architect the sources of supply and manufacturer's specifications, quality control, product data, test reports, and instructions for handling, storage, installation and protection for the following:
1. Wood for Raised Garden Bed Over Structure:
a. MECHANICAL CERTIFICATION: A test report from an independent U.S. testing laboratory indicating conformance to Ipe wood mechanical properties in accordance to the procedures outlined in ASTM Test Method D143 shall be submitted with the material bid.
b. INSPECTION CERTIFICATION: A Certificate of Grade and Inspection from an independent third party inspection and grading agency, Mallinckrodt or pre-approved equal, indicating compliance with material specifications as to producing mill, Iron Woods FEQ grade, species, dimensions, quantity, condition, packaging, and documentation. Inspection will include the physical examination of 100% of the timber produced against the buyer's order, piece by piece, prior to packaging. Inspections are to take place at the mill throughout production and the certificate is to be submitted with the material prior to delivery.
c. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
d. For metal framing anchors include installation instructions.

B. Samples: Submit samples of the following materials. Samples shall be representative of the workmanship and finishes to be incorporated in the completed Project.
1. Wood Slats:
a. Submit six (6) full-size typical slats, showing the range of variation to be expected in appearance of wood slats.
b. The approved samples will set the finish standard for the Work. Greater variation than is represented in the approved samples will not be accepted in the finished work.
c. Product Certificates: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.

C. Shop drawings showing fabrication and installation of custom planters including plans, elevations, details of components, and attachments to other units of Work. Indicate materials and profiles of each member, fitting, joinery, finishes, fasteners, anchorages, and accessory items.
1. Submit complete drawings for entire planter assembly showing shop sizes and shapes, including, thickness, jointing, expansion joints, anchoring, connection with other adjacent work, typical and special anchoring details, and field verified conditions and dimensions. Show electrical connections. Field measurement drawings, as reference only, shall also be submitted with shop drawings.
2. Drawings shall show relationship to adjoining construction after fabrication and, shall indicate the location of each wood unit and metal with a number designation corresponding to number marked on each unit.

a. Show location layouts and patterns coordinated with design drawings and related survey control points and dimensions. Establish and verify dimensions with concrete work of on-site structures and elements, masonry layouts, patterns of other work, and other like conditions.
b. Show location, type, and extent of anticipated field cutting.

3. Do not fabricate any custom wood elements (except for mockups) until Shop Drawings have been approved for fabrication by the Landscape Architect.

D. Field Constructed Mock-ups: Construct at the earliest possible time and at approved location, before proceeding with Work and after Landscape Architect's approval of submitted samples. Submit proposed locations for field mockups and receive approval of locations from Landscape Architect prior to construction of field mockups. Provide and construct entire planter assembly as specified herein to show appearance, workmanship, and finish of work, complete and in coordination with work of other Sections as applicable.
1. Install mock-ups of planter assembly unless otherwise directed. Coordinate with materials requirements as specified in other sections.
2. The field mock-up must be approved by Landscape Architect before all the planter assembly may proceed. Accepted mockup establishes minimum standard of quality and workmanship for work of this Section.
3. Demolish and remove field mockups at a time approved by Landscape Architect when no longer required to serve as a standard of work. Mock-up may be incorporated as part of Work if conforming to specified requirements, and if accepted by Landscape Architect.

E. Maintenance Program: Submit a maintenance program to be followed by the Contractor during construction and by the Owner during the Warranty Period, including provisions, such as temporary protection measures, to protect planter assembly.

1.5 QUALITY ASSURANCE

A. The work of this section shall be performed by companies which specialize in the type of wood work required for this Project, certified in writing, with a minimum of 10 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.

B. Fabrication Qualifications: Fabrications shall be by a firm or firms, which have successfully fabricated each material type and condition, similar to the quality specified, and in the quantity shown for a period of not less than five (5) years.
1. The Landscape Architect and Owner may during the course of the work visit the places of fabrication. The Contractor shall afford these representatives free access and cooperation in the performance of their duties.

C. Installer Qualifications: Installers shall have a minimum of ten (10) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere, in the installation of the wood materials specified, and the products, systems, and scope specified. An experienced (10 years experience) field foreman shall oversee all work. Include evidence of experience including project list.

D. Forest Certification: All wood shall be harvested from forests certified by the Forest Stewardship Council (FSC) and all wood products shall be Chain of Custody certified.
1. "Certified Forest Products Council" Purchasing Policy Guidelines: In an effort to promote sustainable forest management, the material supplier will provide proof of membership in

the Certified Forest Products Council as confirmation of their commitment to the development of sustainable forest resources.

2. "Forest Stewardship Council" Endorsed Third Party Certification: In an effort to promote sustainable forest management, the supplier will provide proof of Chain Of Custody Certification status in an FSC endorsed certification program as an example: Rainforest Alliance SmartWood© Program or approved equal.

E. Welding Standards: Refer to Division 05 “Metal Fabrications”.

F. Field Measurements and Coordination: Verify dimensions with existing conditions and with work specified in other sections which adjoins the work herein specified or to which this work will be attached.
1. Coordinate with related work of other sections, including work of other separate contracts.
2. Field Measurement Drawings: Measurements of adjoining work shall be taken, so that work specified in this Section shall fit closely into spaces provided, and shall allow correct access and clearance at conditions. Measurements shall include both horizontal dimensions and vertical grades. Employ a qualified surveyor as required. Contractor shall prepare a field measurement drawing at a scale of 1/2" = 1' 0" or larger showing existing adjoining work, including, but not limited to conduits and all foundations for structural elements. Drawings will be prepared prior to preparation of shop drawings, and shall be submitted, for reference only, with shop drawing submittal.
3. If any unusual conditions are encountered, the nature and location of conditions shall be shown on shop drawings submitted to the Landscape Architect for determination and approval prior to fabrication.
4. Furnish all necessary templates and patterns required by work of other sections. Furnish components of assemblies that are to be built into work specified as part of other sections.

G. Shop Assembly: To the extent practicable, fitting and assembly of work shall be done in the shop. All work shall be accurately and neatly fabricated, assembled and erected with smooth finish surfaces.
1. Work that cannot be permanently shop-assembled, shall be completely assembled, marked for re-assembly and disassembled in shop before shipment to insure correct assembly in the field.
2. Shop assemble work in largest practical sizes to minimize field work.
3. Shop fabricated items shall properly fit the field condition. In the event that shop fabricated items do not fit the field condition, the item shall be returned to the shop for correction.
4. Connections in the field shall be with approved mechanical fasteners. Welding of assemblies or components in the field shall not be permitted, unless approved in writing by the Landscape Architect and correct protective measures are implemented.

H. Pre-installation Meeting: Before beginning work, schedule and conduct a meeting at the site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Owner, Landscape Architect, Contractor, the installers, and the installers' field foremen. Inform the Landscape Architect ten (10) business days in advance of the scheduled meeting time.

1.6 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affection transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store wood elements inside a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity. Store products on elevated platforms in a dry location.

B. Deliver wood planter assemblies wrapped in protective coverings or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

1.8 PROJECT CONDITIONS

A. Field Measurements: Where wood elements are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match materials installed and that are packaged for storage and identified with labels describing contents.
   1. Wood Slats: Twelve (12) extra pieces of each type

B. Packing requirements: Extra materials shall be packed in heavy duty corrugated cardboard boxes. Label each box with list of contents.

PART 2 - PRODUCTS

2.1 FINISH WOOD

A. All finish wood surfaces for all planters shall be: Ipe (Handroanthus spp), unless otherwise specifically indicated on drawings. Available manufacturers as available below or approved equal:
   1. Ironwoods | Timber Holdings USA
      Tel: 414-445-8989
      Email: info@ironwoods.com

B. Finish Wood Lumber Grade: All lumber shall be third party graded and inspected to (Premium Select Clear All Heart) grading rules, defined as follows:
   1. Lumber shall be graded four faces, and four edges.
   2. Lumber shall be straight grained and parallel cut without heart center.
   3. Lumber shall be all heartwood, no sapwood allowed.
   4. Lumber shall be in sound condition, free from worm holes or knots.
   5. Sawn ends shall be finished with Anchor sealer.
   6. Allowable Imperfections defined as - Small drying cracks, small end splits (less than 5/32 inches in width), that do not impair the strength of the material or fastening, Discoloration caused by weathering or chemical reaction, Bow or twist which can be removed using normal installation methods and tools, Roey/Scale grain (one face only).
   7. Not Allowable Imperfections defined as - Longitudinal heart cracks, Internal cracks, Firm or soft sap wood, Fungi Affects - (blue to gray, brown to red, white to yellow, or incipient decay), Bow or twist which cannot be removed by normal installation methods and tools.
   8. Mechanical Properties: Wood supplied shall meet or exceed mechanical properties as defined by U.S. Forest Product Laboratories testing methods. The values for mechanical properties based on the 2" standard are as follows:

Ipe (*Handroanthus spp*)			
Moisture Content	Bending Strength	Modulus of Elasticity	Max. Crush Strength
12%	25,400 psi	3,140,000 psi	13,010 psi
Janka side hardness is 3,680 lb. at 12% M.C.			
Average air dry density is 66 to 75 pcf.			
Basic specific gravity is 0.85-0.97			

C. Finish: No finish shall be applied; finish shall be natural.

2.2 MISCELLANEOUS MATERIALS

A. Wood Coping Fasteners: Provide Type 316L stainless steel fasteners, complying with requirements of ASTM F593-95 and ASTM F594-91. Select fasteners for type, grade, and class required.
   1. Provide concealed fasteners for interconnection of components and for their attachment to other work, except where otherwise indicated.
   2. Provide vandal proof flat-head machine screws for exposed fasteners, unless otherwise indicated.

B. All other fasteners and supports shall be stainless steel.

2.3 FABRICATION

A. Form custom fabrications to required shapes and sizes, with true curves, lines, and angles.

B. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Drill and tap for required fasteners, unless otherwise indicated. Use concealed fasteners wherever possible.

C. Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing wood planters, as applicable to each unit of work.

D. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.

E. Finish exposed surfaces, including welds, to smooth, sharp, well-defined lines and arises.

F. Assemble 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. Use connections that maintain structural value of joined pieces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspection: Verify the conditions, elevations, and measurements affecting the work of this Section prior to installation. Examine locations to receive planter and do not proceed until any defects detrimental to the finished work are corrected. Take proper precautions so as not to disturb or damage subsurface elements of utilities, conduits, underdrainage systems, water proofing, insulation, or foam fill.

3.2 PREPARATION

A. Coordinate and furnish anchorages and setting drawings, diagrams, templates, instructions, and directions for installing items having integral anchors that are to be embedded in concrete construction. Coordinate delivery of such items to the Project site.

3.3 INSTALLATION

A. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction.

B. Perform cutting, drilling, and fitting required to install custom fabrications. Set products accurately in location, alignment, and elevation, plumb, level, and true, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of miscellaneous metal items, restore finishes to eliminate any evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at the same location.
   1. Retain protective coverings intact and remove simultaneously from similarly finished items to preclude non-uniform oxidation and discoloration.

F. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

3.4 PROTECTION

A. Protect finishes of planters from damage during construction period with temporary protective coverings approved by fabricator. Remove protective covering at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction so that no evidence remains of correction work. Return items that cannot be refinished in the field as determined by the Landscape Architect to the shop; make required alterations and refinish entire unit; or provide new units as required.

3.5 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day’s work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 321170

SECTION 070543.11 - COMPOSITE METAL HYBRID (CMH) CONTINUOUS INSULATION SUB-FRAMING SUPPORT SYSTEMS

PART 1- GENERAL

1.01 SECTION INCLUDES

A. Composite metal hybrid (CMH) sub-framing support system with in-fill continuous insulation integrated within exterior wall cladding.

1. Substrate: Exterior sheathing over metal stud framing.

1.02 RELATED REQUIREMENTS

A. Section 054000 – Cold-Formed Metal Framing: Metal stud substrate support framing.

B. Section 061600 – Sheathing.

C. Section 072100 – Thermal Insulation.

D. Section 072726.04 – Fluid-Applied Membrane Air Barriers.

E. Section 074213.23 – Metal Composite Material Wall Panels.

F. Section 074243 – Wood Veneer Laminate Wall Panels.

G. Section 079200 – Joint Sealants: Perimeter sealant.

1.03 REFERENCE STANDARDS

A. ASCE American Society of Civil Engineers (www.asce.org).

1. ASCE 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2022.

B. ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers (www.ashrae.org).

1. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019.

2. ASHRAE 189.1 – Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings; 2020.

C. ASTM International (American Society for Testing and Materials; www.astm.org).

1. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.

3. ASTM C303 - Standard Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation; 2021.

7. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

8. ASTM C1177/C1177M – Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

9. ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2022a.

10. ASTM C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus; 2019.

11. ASTM C1396/C1396M – Standard Specification for Gypsum Board; 2017(2022).

12. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 10(2018).

13. ASTM D570 – Standard Test Method for Water Absorption of Plastics; 2022.

14. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

15. ASTM D638 – Standard Test Method for Tensile Properties of Plastics; 2022.

16. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between minus 30 degrees C and 30 degrees C with a Vitreous Silica Dilatometer; 2016.

17. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.

18. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement; 2020.

19. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016.

20. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

21. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics; 2017.

22. ASTM D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging; 2020.

23. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.

24. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products; 2019.

25. ASTM D6641/D6641M - Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression (CLC) Test Fixture; 2016e2.

26. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

27. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a.

28. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.

29. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference; 2014(2021).

30. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

D. IBC – International Building Code (ICC - International Code Council); 2021.

E. IECC – International Energy Conservation Code; 2021.

F. IgCC – International Green Construction Code; 2021.

G. NFPA – National Fire Protection Association (www.nfpa.org).

1. NFPA 285 – Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate installation of continuous insulation sub-framing support system as indicated on drawings for proper drainage, flashing, trim, backup support, soffits, and other related Work.

1. Review and finalize construction schedule.

2. Verify availability of materials, installer's personnel, equipment, and facilities needed to meet established schedule.

3. Review means and methods related to installation in accordance with manufacturer's installation instructions.

4. Examine support conditions for compliance with installation requirements, including alignment and attachment to structural support system.

5. Review flashings, wall cladding details, wall penetrations, drainage plane, openings, and condition of other construction that is related to this Work.

6. Review temporary protection requirements for during and after installation of this Work.

1.05 SUBMITTALS

A. Product Data: Submit for each product being used and as indicated, including installation details, material descriptions, dimensions of individual components and profiles, and necessary accessories for a complete assembled system.

1. Continuous insulation (CI) support system attachment methods and required fasteners.

2. Wall-mounted items, including doors, windows, louvers, and light fixtures.

3. Wall penetrations, including pipes, electrical fixtures, and any other wall-mounted utilities.

B. Shop Drawings: Submit project specific shop drawings prepared by, or under supervision of, Structural Design Engineer as specified in Quality Assurance article below and including Structural Design Engineer's stamp or seal on all shop drawings including system attachments and anchors.

1. Include fabrication and installation layouts of system; project specific details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, accessories, and special details. Include details showing integration of metal composite material wall panel system with air barrier system.
2. Accessories: Include project specific details of flashing, trim, and anchorage, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
3. Provide signed and sealed drawings, by a qualified design professional in Project jurisdiction, of system showing compliance with performance requirements and design criteria identified for this Project.

B. Test and Inspection Reports: Submit test and inspection reports on each type of wall cladding/veneer system based on evaluation of comprehensive tests performed by testing agency approved by authorities having jurisdiction.

C. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work as indicated in this section with at least three years of documented experience and approved by manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site without damage or deformation in manufacturer's original unopened containers and with labels that clearly identify product name and manufacturer.

B. Storage: Store materials in clean, dry, and level interior or exterior areas for limited duration in accordance with manufacturer's written instructions.

C. Protect components during transportation, handling, and installation from moisture, excessive temperatures, and other construction operations in accordance with manufacturer's written instructions.

D. Handle components in accordance with manufacturer's written instructions and in a manner to prevent bending, warping, twisting, and surface, edge, or corner damage.

1.08 SITE CONDITIONS

A. Weather Limitations: Only proceed with installation when existing and forecasted weather conditions allow for assembly of this Work in accordance with manufacturer's written installation instructions.

1.09 WARRANTY

A. Manufacturer's Warranty: Provide 1-year manufacturer's warranty for composite metal hybrid (CMH) sub-framing support system commencing on the date of Substantial Completion.

PART 2- PRODUCTS

2.01 MANUFACTURER

A. Basis-of-Design Product: Subject to compliance with requirements, provide Advanced Architecural Products (A2P); GreenGirt CMH Sub-Framing System; SMART ci 1 in 1 System or comparable product by one of the following;

B. Armetherm Thermal Bridging Solutions; Armatherm Z Girt.

C. Strongwell; STRONGIRT.

2.02 DESCRIPTION (FRP FURG-1)

A. Attach CMH sub-framing support system components through exterior sheathing into metal stud framing as indicated on drawings.

B. Install CMH sub-framing support system components horizontally or vertically through exterior sheathing into stud support system as indicated on drawings in compliance with project requirements.

C. Install metal hat channel as indicated on drawings, mounted horizontally to vertical or vertically to horizontal CMH sub-framing support system, connecting adjacent supports in series to each other.

2.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide system tested in accordance with ASTM E330/E330M and certified to be without permanent deformation or failure of structural members in accordance with design wind velocities for project location and potential for occurance based on data from wind velocity maps and other provisions of ASCE 7 and as approved by authorities having jurisdiction (AHJ).

1. Design Loads: As indicated on Drawings.

Measure performance of assembly using test loads equal to 1-1/2 times design wind loads indicated and with 10-second duration at maximum pressure.

B. System Thermal Design: Ensure that installed continuous insulation and CMH sub-framing support system, and cladding attachment does not have thermal bridging of fasteners or framing that creates a continuous metal path from exterior surface of insulation to interior face of insulation.

1. Verify that system thermal design meets or exceeds thermal design requirements in accordance with ASHRAE 90.1 ASHRAE 189.1 IECC or IgCC energy code.

2. Thermal Resistance, Overall: Refer to Architectural Exterior Wall Types on Drawings.

3. Thermal Performance Test: Provide thermal resistance (R-value) indicated, in accordance with ASTM C1363, corrected to 15 mph wind outside and still air inside, with installed condition including fasteners and joints.

a. Provide efficiency of no less than 93 to 98 percent, with a maximum temperature differential of 18 degrees F from interior wall surface to interior wall cavity and node locations with a 70 degrees F exterior to interior wall temperature delta.

b. Provide test unit with at least one insulation panel horizontal and vertical joint length and height of test chamber area.

c. Provide finite element analysis of three-dimensional simulation of described wall assembly sealed by a professional engineer in compliance with code performance requirements and exceeding it by at least 3 percent.

C. Temperature Range: Comply with structural loading requirements within a temperature range of minus 55 degrees F to 180 degrees F.

D. Fire-Resistance Ratings: Provide CMH sub-framing support system with fire testing in accordance with ASTM E119 test methods and applied by approved testing agency acceptable to authorities having jurisdiction (AHJ).

1. Surface Burning Characteristics: Test in accordance with ASTM E84 test method for continuous insulation, composite metal hybrid (CMH) and interior surfaces as follows:

a. Flame Spread Index (FSI): 25 or less.

b. Smoke Developed Index (SDI): 450 or less.

Intermediate Scale Multistory Fire Test: Comply with NFPA 285 and/or IBC acceptance criteria for wall height above grade and fire separation distances when wall type and other noted conditions require such testing or compliance with requirements as indicated.

2.04 COMPOSITE METAL HYBRID (CMH) SUB-FRAMING SUPPORT SYSTEM

A. CMH Sub-Framing Support System: Provide CMH sub-framing support system consisting of polyester resin matrix with recycled materials, fire retardant additives and reinforced with integral continuous metal inserts the full length with pre-drilled holes to align with substrate fastening locations.

1. Length of CMH Support System: 96 inches long.
2. Depth of CMH Support System: Refer to Architectural Wall Types on Drawings.
3. Grid Spacing of CMH Sub-Framing Supports for Substrate Attachments: Refer to Architectural Wall Types on Drawings.
4. Fastener Retention System: Provide continuous galvanized steel insert for engagement of fasteners, at least 16 gauge thick, with G90 galvanized coating in accordance with ASTM A653/A653M.
   a. Fasten CMH sub-framing support and other wall cladding support accessories through steel insert located within top and bottom of CMH sub-framing.
   b. Provide at least 3 inch overlap of metal inserts between CMH supports with 3/16 inch wide gap; sealant is not required.
5. Provide integral compression seal within CMH sub-framing to ensure insulation will not dislodge.
6. Provide integral anti-siphon grooves on exterior and interior flanges of CMH sub-framing.
7. Provide force distribution zones integrally designed into profile of CMH sub-framing.
8. CMH sub-framing is self-extinguishing in accordance with ASTM D635.
9. Visual defects in CMH sub-framing is classified in accordance with ASTM D4385.
10. Tensile Properties: Engineered lengthwise and crosswise tensile properties of CMH sub-framing comply with performance loading criteria and specified safety factors in accordance with ASTM D638.

a. Lengthwise 50,000 psi and crosswise 40,000 psi, minimum.

11. Compressive Properties: Engineered lengthwise and crosswise compressive properties of CMH sub-framing comply with performance loading criteria and specified safety factors in accordance with ASTM D6641/D6641M.

    a. Lengthwise 50,000 psi and crosswise 30,000, minimum.

12. Flexural Properties: Engineered lengthwise and crosswise flexural properties of CMH sub-framing comply with performance loading criteria and specified safety factors in accordance with ASTM D790.

    a. Lengthwise 50,000 psi and crosswise 40,000 psi, minimum.

13. Modulus of Elasticity: CMH sub-framing is engineered to meet performance loading criteria and specified safety factors in accordance with ASTM D638.

    a. Lengthwise 29,000,000 psi and crosswise 3,300,000 psi, minimum.

14. Water Absorption: CMH sub-framing absorbs less than 0.46 percent by weight within 24 hours when tested in accordance with ASTM D570.

15. Relative Density: CMH sub-framing is within range of 0.062 to 0.070 lbs/cubic inch when tested in accordance with ASTM D792.

16. Coefficient of Linear Thermal Expansion: CMH sub-framing is at 7.0 x 10^{-6} inch/inch/degrees F when tested in accordance with ASTM D696.

17. Notched Izod Pendulum Impact Resistance, Lengthwise: CMH sub-framing is at 160 ft lbs/inch when tested in accordance with ASTM D256 within standard temperature range.

18. Notched Izod Pendulum Impact Resistance, Crosswise: CMH sub-framing is at 100 ft lbs/inch when tested in accordance with ASTM D256 within standard temperature range.

2.05 ASSEMBLY

A. Assemble CMH sub-framing support system in accordance with manufacturer's installation instructions and as necessary to comply with performance requirements indicated.

    1. Comply with CMH sub-framing support system dimensional and structural requirements as indicated on drawings.

    2. Install CMH sub-framing support system in acceptable sequence in accordance with manufacturer's written installation instructions.

    3. Install spray foam sealant on backside of cantilevered fasteners that completely puncture insulation layer.

2.06 ACCESSORIES

A. Provide necessary accessories for complete installation of CMH sub-framing support system including metal closure trim, transition angle, strapping, tie-in brackets, and other similar items.

B. Fasteners: Corrosion-resistant, self-tapping and self-drilling screws, bolts, nuts, and other fasteners as recommended by CMH sub-framing support system manufacturer for CMH materials and other project applications.

    1. Cladding to CMH: Use standard self-tapping metal screws.

2. CMH to Metal Stud Wall Framing: Use standard self-tapping metal screws.

3. CMH to Concrete or Concrete Masonry Units (CMU): Use standard masonry or concrete screw anchors in pre-drilled hole.

5. Use of powder, air, or gas-actuated fasteners or actuated fastener tools is not permitted.

6. Use of impact wrenches when fastening to or from CMH is not permitted.

PART 3- EXECUTION

3.01 EXAMINATION

A. Examine areas of this Work, substrates, and other project conditions with installer present to verify compliance with requirements for installation tolerances, substrates, CMH sub-framing support system conditions, and other conditions relating to this Work.

B. Examine structural wall framing to ensure that angles, channels, studs, and other structural support members have been installed within alignment tolerances in accordance with installation instructions of CMH sub-framing support system manufacturer.

C. Examine components and systems penetrating CMH sub-framing support system prior to installation during rough-in stage of construction to coordinate actual locations of penetrations relative to CMH sub-framing support systems joint locations.

D. Verify that mechanical and electrical-related installations for exterior walls have been completed, and verify that adjacent materials and finishes are dry and ready for insulation installation.

E. Proceed with installation of CMH sub-framing support system only after wall substrate surfaces have been properly prepared and unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare substrate surfaces using methods recommended in writing by CMH sub-framing support system manufacturer to achieve excellent results under project conditions.

C. Prepare sub-framing, base angles, sills, furring, and other CMH sub-framing support system components and provide anchorage in accordance with ASTM C754 for substrate and wall cladding types in accordance with manufacturer's installation instructions.

3.03 INSTALLATION

A. Install CMH sub-framing support system in accordance with manufacturer's written installation instructions, and in compliance with system orientations, sizes, and locations as indicated on drawings.

B. Install continuous insulation system without gaps or voids, provide insulation fill-in at necessary locations, and do not compress insulation panels.

C. Trim insulation neatly to tightly fit spaces within plane of continuous insulation.

D. Exterior wall continuous insulation is not intended to be left exposed for extended periods of time; protect exposed insulation from open flame.

3.04 TOLERANCES

A. Shim and align CMH sub-framing support system with installation tolerances of 1/4 inch in 20 feet, non-cumulative, level, plumb, and aligned with locations as indicated on drawings.

3.05 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

B. Ensure that insulation panels are not exposed to moisture.

Remove wet insulation panels or allow them to completely dry prior to installation within CMH sub-framing support system.

C. Replace damaged insulation prior to Date of Substantial Completion.

END OF SECTION 070543.11

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

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. Modified bituminous sheet waterproofing.
2. Molded-sheet drainage panels.
3. Insulation drainage panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, inspection procedures, and protection and repairs.

1.4 ACTION 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. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.

C. Shop Drawings: Show locations and extent of waterproofing and project specific details of substrate joints and cracks, expansion joints, 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 (200-by-200-mm) square of waterproofing and flashing sheet.
2. 4-by-4-inch (100-by-100-mm) square of drainage panel.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Research Reports: For modified bituminous sheet waterproofing/termite barrier, showing compliance with ICC AC380.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

E. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer. Installer shall have 5 years of experience in applying the same or similar materials and shall be specifically approved in writing by the membrane manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build for each typical waterproofing installation including accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

    a. Size: 100 sq. ft. (9.3 sq. m) in area.
    b. Description: Each type of wall installation.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.8 WARRANTY

A. Manufacturer's Warranty:

1. Waterproofing Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

a. Warranty Period: Five years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING (WP-1)

A. Modified Bituminous Sheet Waterproofing: Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Carlisle Coatings & Waterproofing Inc ; CCW MiraDRI 860/861. or a comparable product by one of the following:

a. GCP Applied Technologies Inc.; Bituthane System 3000.
b. Henry Company; Blueskin WP 200.
c. W.R. Meadows, Inc.; MEL-ROL.

2. Physical Properties:

a. Tensile Strength, Membrane: 250 psi (1.7 MPa) minimum; ASTM D412, Die C, modified.
b. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D1970/D1970M.
d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C836/C836M.
e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E154/E154M.
f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D570.

g. Water Vapor Permeance: 0.05 perm (2.9 ng/Pa x s x sq. m) maximum; ASTM E96/E96M, Water Method.
h. Hydrostatic-Head Resistance: 200 feet (60 m) minimum; ASTM D5385.

3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 AUXILIARY MATERIALS

A. 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 primer recommended for substrate by sheet waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm), predrilled at 9-inch (229-mm) centers.

2.4 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft. (112 to 261 L/min. per m).

1. Basis-of-Design Product: Subject to compliance with requirements, provide Carlisle Coatings & Waterproofing Inc; CCW MiraDRAIN 6000 or a comparable product by one of the following:

a. GCP Applied Technologies Inc.
b. Polyguard Products, Inc.
c. Soprema, Inc.
d. W.R. Meadows, Inc.

2.5 INSULATION DRAINAGE PANELS

A. Insulation: Comply with Section 072100 "Thermal Insulation" for general building insulation, including insulation drainage panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of waterproofing.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections.

E. Fill form tie holes, honeycomb, aggregate pockets, holes, and other voids.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D4258.

1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm).

G. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.

1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.

H. Corners: Prepare, prime, and treat inside and outside corners in accordance with manufacturer's instructions.

1. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:

a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.

I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions.

B. Apply primer to substrates at required rate and allow it 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- (64-mm-) minimum lap widths and end laps. Lap in the direction of the flow of water. 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 (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).

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 two thicknesses of sheet membrane over areas to receive waterproofing.

E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

F. Seal edges of sheet waterproofing terminations with mastic.

G. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.

H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

I. Immediately install protection course with butted joints over waterproofing membrane.

1. Insulation drainage panels may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.4 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.5 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.

3.7 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071326

SECTION 071413 - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

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. Rubberized-asphalt waterproofing membrane.
2. Insulation.

1.03 RELATED SECTIONS

A. DIVISION 32 - Exterior Improvements - Paving/Site Furnishings.

B. DIVISION 03 - Concrete - Roof Deck Surface/Substrate
The coordination of this section is necessary to facilitate the successful installation of the waterproofing membrane.

Cast in Place Concrete/Composite Deck

1. Strength/density: minimum 2,500 psi (17,235 kPa) compressive strength
   minimum 115 pcf (1842 kg/m^3) density
2. Finish: Wood-float or wood-troweled equivalent finish. Steel troweled finish is not desirable.
3. Concrete Hydration (Cure):
   a. Method of Cure: Water cure, wet coverings, paper sheets, plastic sheets or approved liquid curing compound (sodium silicate preferred).
   b. Duration of Cure/Dry:
      i. Structural Weight Concrete: recommend 28 days, minimum 14 days, prior to application of the membrane.
      ii. The above minimum cure/dry times are recommended based upon basic concrete fundamentals and experience. Depending on conditions (i.e., ambient temperature, humidity) the concrete may be dry enough to receive application of the membrane in less than the 14 day minimum recommendation. Consult Manufacturer for specifics when less than the minimum is desired.
   c. Form Release Agents: Contact Manufacturer.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. International Concrete Repair Institute (ICRI) Concrete Surface Profile (CSP) Scale.

1.05 SYSTEM DESCRIPTION

A. Furnish and install a completed vertical or horizontal waterproofing assembly including surface conditioner, Monolithic Membrane 6125EV-FR and related flashings, protection course, insulation, and drainage course.

1.06 SUBMITTALS

A. Certification from an approved independent testing laboratory experienced in testing this type material, that the material meets the CGSB-37.50-M89 standard for rubberized asphalt membranes, including applicable ASTM procedures.

B. Certification showing full time quality control of production facilities responsible for the manufacture of the rubberized asphalt and that each batch of material is tested to insure conformance with the manufacturer's published physical properties.

C. Certification showing that all waterproofing components are being supplied and warranted by a single-source manufacturer.

D. Evidence that extruded polystyrene insulation if used is free from CFC's.

E. The plant manufacturing this type material shall have ISO 9001-2000 approval as evidenced by a copy of the official certificate.

F. Shop Drawings: Project specific. Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions. Include integration with adjacent materials.

G. Product Data: For each type of product. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

H. Product samples.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

D. Installation instructions.

1.08 QUALITY ASSURANCE

A. The Waterproofing Contractor shall demonstrate qualifications to perform the work of this Section by submitting the following documentation:

1. Certification or license by the membrane manufacturer as a locally based, authorized applicator of the product the installer intends to use, for a minimum of five (5) years.
2. List of at least three (3) projects, satisfactorily completed within the past five (5) years, of similar scope and complexity to this project. Previous experience submittal shall correspond to specific membrane system proposed for use by applicator.

B. Refer to Section 1.05 SYSTEM DESCRIPTION. Include single-source for all components from the manufacturer.

C. The rubberized asphalt membrane product shall contain an inert clay filler and crumb rubber to enable the product to be resistant to acids (fertilizers, building washes and acid rain) and maintain membrane thickness during application respectively.

D. Membrane Manufacturer shall have available an in-house technical staff to assist the contractor, when necessary, in application of the products and final inspection of the assembly.

E. Membrane Manufacturer Qualification: Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:

1. Membrane Manufacturer shall show evidence that the specified rubberized asphalt has been manufactured by the same source for thirty five (35) years and successfully installed on a yearly basis for a minimum of thirty five (35) years on projects of similar scope and complexity.
2. Membrane Manufacturer shall not issue warranties for terms longer than they have been manufacturing their hot fluid rubberized asphalt membrane.

F. Pre-Construction Conferences. The manufacturer will meet with the necessary parties at the jobsite to review and discuss project conditions as it relates to the integrity of the waterproofing assembly.

1.09 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original unopened containers of packaging clearly labeled with manufacturer's name, brand name, instruction for use and all identifying numbers.

B. Materials shall be stored in a neat, safe manner, not to exceed the allowable structural capacity of the storage area.

C. Store materials in a clean, dry area protected from water and direct sunlight.

D. Store all adhesives at temperatures between 60°F (15.5°C) and 80°F (26.6°C). If exposed to lower temperatures, restore materials to 60°F (15.5°C) minimum temperature before using.

1.10 PROJECT CONDITIONS

A. Application of the membrane shall not commence nor proceed during inclement weather. All surfaces to receive the membrane shall be free of water, dew, frost, snow and ice.

B. Application of membrane shall not commence nor proceed when the ambient temperature is below 0°F (-17.7°C) or as required by manufacturer.

C. Preparation and application of membrane shall be conducted in well ventilated areas.

D. Over its service life, do not expose membrane or accessories to a constant temperature in excess of 180°F (82°C) (i.e., hot pipes and vents or direct steam venting, etc.).

E. Adhesives contain petroleum distillates and are extremely flammable. Do not breathe vapors or use near an open fire. Do not use in confined areas without adequate ventilation. Consult container or packaging labels and Material Safety Data Sheets (MSDS) for specific safety information.

F. Do not allow waste products (petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat, etc.) to come in contact with the waterproofing membrane. Any exposure to foreign materials or chemical discharges shall be presented to membrane manufacturer or evaluation to determine any impact on the waterproof membrane assembly performance.

G. Concrete Deck/Wall Surface Condition. IMPORTANT - Refer to 1.03 Related Sections.

H. Deck/Wall Preparation; refer to Section 3.02 Preparation.

I. General contractor shall assure that adequate protection is provided after installation of the membrane and accessories to prevent damage from subsequent trade traffic.

1.11 WARRANTY

A. Upon completion of the work, the contractor shall supply the owner with a single-source warranty of U.S. origin direct from the manufacturer.

B. Each warranty varies in scope and terms. CONTACT Manufacturer for exact warranty terms and conditions to meet the specific project requirements.

C. Warranties available from the manufacturer:

1. Total System Warranties; covers components of the waterproofing assembly, including membrane, flashing, and insulation.

    a. 20-year (watertight condition) from Date of Substantial Completion. No dollar limit.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Section 1.05, SYSTEM DESCRIPTION. All components shall be obtained as a single-source from the membrane manufacturer to ensure total system compatibility and integrity.

Basis-of-Design Manufacturer: American Hydrotech, Inc.; 6125EV (WP-2)

Other approved Manufacturers/Products: Barrett Company; RamTough 250, Carlisle Coatings & Waterproofing, Inc.; CCW-500R, Henry Company; 790-11. Tremco Incorporated; TREMproof 6100.

2.02 MATERIALS

A. Membrane

1. Membrane shall be a hot, fluid applied, rubberized asphalt membrane meeting the CGSB-37.50-M89 standard and other pertinent physical properties:

a. American Hydrotech, Inc., Monolithic Membrane 6125®EV (up to 40% post consumer recycled content)

PROPERTY	TEST METHOD	TYPICAL RESULT
Flash point	ASTM D-92 CGSB-37.50-M89	502°F* <500°F (261°C) (260°C)
Penetration	ASTM D-5329 CGSB-37.50-M89	98 mm @77°F (25°C) 187 mm @122°F (50°C)
Flow	ASTM D-5329 CGSB-37.50-M89	1.0 mm @ 140°F (60°C)
Toughness	CGSB-37.50-M89	16.0 Joules
Ratio of Toughness to Peak Load	CGSB-37.50-M89	0.069
Water Vapor Permeability	ASTM E-96, PROCEDURE E CGSB-37.50-M89	0.3 ng/Pa(s)M^2
Water Absorption	CGSB-37.50-M89	.11 gram weight gain
Low Temperature Flexibility (-25°C)	CGSB-37.50-M89	No delamination, adhesion loss, or cracking

Low Temperature Crack Bridging Capability	CGSB-37.50-M89	No cracking, adhesion loss, or splitting
Heat Stability	CGSB-37.50-M89	No change in viscosity, penetration, flow or low temperature flexibility
Viscosity	CGSB-37.50-M89	11.0 seconds
Water Resistance (5 days/50°C)	CGSB-37.50-M89	No delamination, blistering, emulsification, or deterioration
Softening Point	ASTM D-36	180°F (82°C)
Elongation	ASTM D-5329	1000% minimum
Resiliency	ASTM D-5329	40% minimum
Bond to Concrete	ASTM D-5329	Pass 0°F (-18°C)
Acid Resistance	ASTM D-896 Procedure 7.1 (N-8)	Pass-50% Nitric Acid -50% Sulfuric Acid
Resistance to Hydrostatic Pressure	ASTM D-08.22 Draft 2 (developed: D5385)	100 psi (equals 231 foot of head water)
Resistance to Salt Water	ASTM D-896 similar 20% sodium chloride sodium carbonate calcium chloride	No delamination, blistering, emulsification or deterioration
Resistance to Fertilizer	ASTM D-896 similar undiluted, 15/5/5, nitrogen/phosphorus potash	No delamination, blistering, emulsification or deterioration
Resistance to Animal Waste	3-year exposure	No deterioration
Solids Content		100%-no solvents
Shelf Life		10 years (sealed)
Specific Gravity		1.15 + .02

*102°F more than the application temperature recommended by the manufacturer.

B. Surface Conditioner

1. Asphaltic surface conditioner for concrete surfaces.
   - American Hydrotech, Inc., Surface Conditioner

C. Flashing/Reinforcing

1. 60-mil (1.5 mm) thick, uncured neoprene flashing/(heavy duty) reinforcing sheet.
   - American Hydrotech, Inc., Flex Flash UN®
2. Spunbonded polyester fabric (standard duty) reinforcing sheet.
   - American Hydrotech, Inc., Flex Flash F®
3. Woven fiberglass fabric reinforcing sheet (vertical applications only)
   - American Hydrotech, Inc., Flex Flash FV® (vertical)

4. Two-component, liquid applied resin membrane flashing system.

   a. American Hydrotech, Inc., HydroSeal Resin
      - poly methyl-methacrylate (PMMA) resin

   b. American Hydrotech, Inc., HydroSeal Matrix
      - acrylic resin with integral chopped polymer fiber reinforcement

   c. American Hydrotech, Inc., HydroSeal Flashing Accessories
      - resin based primers, additives, reinforcing fleece, surfacing topcoats

D. Adhesives/Sealant

1. Contact adhesive to bond elastomeric flashing together.
   - American Hydrotech, Inc., Splicing Cement
2. Pressure sensitive butyl tape to bond elastomeric flashing together.
   - American Hydrotech, Inc., Splice Tape
3. Contact adhesive to bond elastomeric flashing to an approved substrate.
   - American Hydrotech, Inc., Bonding Adhesive
4. Sealant to seal elastomeric flashing seam edge.
   - American Hydrotech, Inc., Lap Sealant

E. Protection Course

1. Fiberglass reinforced rubberized asphalt sheet.
   - American Hydrotech, Inc., Hydroflex® 30

F. Prefabricated Drainage Course

1. Composite drainage system consisting of a three-dimensional, crush-proof, drainage core and a filter fabric meeting the following physical properties.
   - American Hydrotech, Inc., Hydrodrain® 300, 400, 700 or 1000 series

PROPERTY	TEST METHOD	VALUES
CORE:		
Compressive Strength	ASTM D-1621	300/302/1000 - 30,000 psf

		(14.66 kg/cm^2) 400/420 - 15,000 psf (7.32 kg/cm^2) 700 - 18,000 psf (8.79 kg/cm^2)
Thickness	ASTM D-1777	1000 - .25 in (.64 cm) 300/302 - .22 in (.56 cm) 400/420/700 - .40 in (1.016 cm)
Flow, Q @ 3600 psf & hydraulic gradient of 1	ASTM D-4716	300/1000 - 7 gpm/ft width (72.00 lpmin/m width) 302 - 5.5 gpm/ft width (68.30 lpmin/m width) 400/420 - 15 gpm/ft width (183.3 lpmin/m width) 700 - 18 gpm/ft width (223.52 lpmin/m width)
FABRIC:		
Flow	ASTM D-4491	300/302/1000 - 150 gpm/ft^2 (6105 lpmin/m^2) 400/420 - 150 gpm/ft^2 (6105 lpmin/m^2) 700 - 110 gpm/ft^2 (4475 lpmin/ft^2)
U.V. Resistance	ASTM D-4355	Fully Stabilized
Apparent Opening Size (EOS)	CW-02215	300/302/400/420/1000 – 70 (.212mm) 700 – 30 (.60 mm)
Grab Tensile	ASTM D-4632	300/302/400/420/1000 - 90 lbs. (0.4 kN) 700 – 360x260 lbs. (445x355 N)

F. Insulation

1. Insulation: Comply with Section 072100 “Thermal Insulation”.

PART 3 - EXECUTION

3.01 INSPECTION

A. The waterproofing contractor shall examine all surfaces to receive the waterproofing assembly to verify it is acceptable and proper for the application of the membrane.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 and use in-situ probes per ASTM F2170.

B. The waterproofing contractor shall not proceed with the installation of the waterproofing membrane assembly until all deck defects have been corrected.

3.02 PREPARATION

A. All surfaces shall be dry, smooth, free of depressions, voids, protrusions, clean and free of unapproved curing compounds, form release agents and other surface contaminants.

1. Cast in-place concrete (slab or wall)/Composite deck

a. Poured in place concrete shall be monolithic, smooth, free of voids, spalled areas, laitance, honeycombs, and sharp protrusions.
b. Refer to Section 1.02 of this specification, Division 3.

B. Substrate cleaning

1. Thoroughly sweep the substrate which is to receive the waterproofing membrane.
2. Substrate shall also be blown clean using an air compressor to remove any remaining loose debris.
3. Final check to determine if concrete has been properly cleaned is to apply a test patch of Monolithic Membrane 6125® to the surface and check its adhesion.

3.03 INSTALLATION

A. Surface conditioner application (to concrete)

1. Apply the surface conditioner to the concrete using a hand held sprayer evenly at a rate of 300 to 600 SF/gallon (7.4 - 14.7 m^2/L) depending on surface texture. Surface conditioner shall "tan" the surface, not blacken it.
2. Allow sufficient time for the surface conditioner to thoroughly dry prior to the membrane application.

B. Membrane preparation

1. The membrane shall be heated in double jacketed, oil bath or hot air melter with mechanical agitation, specifically designed for the preparation of a rubberized asphalt membrane.
2. Heat membrane until membrane can be drawn-free flowing at a temperature range between 350°F (176°C) and 375°F (190°C).

C. Detailing/Flashing

1. All detailing and flashing shall be done in accordance with the manufacturer's standard guideline details.
2. All detailing and flashing shall be completed before installing the membrane over the field of the substrate.

D. Membrane Application

1. Apply the rubberized asphalt membrane at a rate to provide a continuous, monolithic coat of 90 mil minimum (approximately 2.3 mm), into which is fully embedded a layer of the spunbonded polyester fabric reinforcing sheet, followed by another continuous monolithic coat of membrane at an average thickness of 125 mil (approx. 3.2 mm). Total membrane thickness shall be 215 mils average (approx. 5.5 mm).

2. Overlap fabric reinforcing sheet 1-2 inches (25.4 mm - 50.8 mm) with membrane between sheets.

3.04 SEPARATION/PROTECTION LAYER INSTALLATION

A. Protection layer shall be installed as follows:

1. Embed the protection sheet into the membrane while it is still warm to insure a good bond.
2. Overlap adjoining sheet edges a minimum of 2"-3" (50.8 mm - 76.2 mm) to insure complete coverage. Rigid insulation board materials shall not be overlapped.
3. The completed membrane/protection assembly shall be covered with subsequent topping materials as soon as possible, within 30 days of membrane installation.

3.05 MEMBRANE INTEGRITY TEST

A. The deck area or portions thereof shall be leak tested by means of electronic testing and by ponding water to check the integrity of the membrane installation. Include expansion joint assemblies in test.

1. VERIFY that the structure can support the dead load weight of a watertest before testing.
2. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing and protecting waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water. Testing agency shall observe flood testing.

    a. Flood to an average depth of 2 inches with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of sheet flashings.
    b. Flood each area for 48 hours.
    c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

3. Electric Field Vector Mapping (EFVM): Testing agency shall survey entire waterproofing area for potential leaks using low voltage EFVM.

    a. The system shall be left in place as a permanent future leak detection system.
    b. NOTE: All penetrations through roof shall be flashed and sealed prior to EFVM testing.
    c. EFVM should be tested prior to and after overburden placement. All trades should be completed with work prior to any testing.

B. In the event of excessive damage to the membrane assembly, electronic breach detection testing shall be required prior to the placement of subsequent overburden materials.

3.06 DRAINAGE COURSE / INSULATION PLACEMENT

A. General

1. Contractor shall examine the deck area to be covered with subsequent topping materials in order to insure that all deck areas have received the membrane, the membrane is free of damage, it is properly protected, and all flashing has been properly installed, before placing the insulation.
2. The drainage course insulation and other subsequent topping materials shall be installed as each section is completed.

B. Prefabricated Drainage Course Placement

1. Install drainage course on horizontal and vertical surfaces in accordance with the manufacturer's recommendations.
2. Layout and position drainage course and allow to lay flat. Cut and fit drainage course to perimeter and penetrations.
3. The geotextile overlapped edges may be bonded to the adjacent drainage course geotextile with an appropriate adhesive to insure continuous geotextile integrity.
4. Place subsequent topping materials as soon as possible.

C. Insulation Placement

1. Loose lay (horizontal applications) in a staggered manner and tightly butt together all insulation boards. The maximum acceptable opening between insulation boards is 3/8" (9.5 mm). Insulation shall be installed within 3/4" (19 mm) of all projections, penetrations, etc.
2. When multi-layer insulation applications are involved the bottom layer of insulation shall be the thickest layer and shall be a minimum of 2" thick (50.8 mm). All layers shall be installed unadhered to each other and all joints staggered in relation to underlying layers.

3. Protect installed board insulation from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
4. For vertical, multi-layer applications, second layer of insulation board shall be spot adhered to the protection layer with appropriate adhesive or additional rubberized asphalt membrane.

3.07 JOB COMPLETION

A. Contractor and a representative of the membrane manufacturer shall inspect the waterproofing assembly and notify the contractor of any defects. All defects shall be corrected.

B. Clean up all debris and equipment.

END OF SECTION 071413

SECTION 072100 - THERMAL INSULATION

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. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Mineral-wool blanket insulation.

B. Related Requirements:

1. Section 071326 "Self-Adhering Sheet Waterproofing"
2. Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing" .
3. Section 075419 "Polyvinyl-Chloride (PVC) Roofing" for insulation specified as part of roofing construction.
4. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Mineral-wool blanket insulation.

B. Manufacturer’s installation instructions.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 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 until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (XPS)

A. Extruded Polystyrene Board Insulation, Type IV, Drainage Panels (INSUL-1): ASTM C578, Type IV, 25-psi (173-kPa) minimum compressive strength; unfaced; fabricated with tongue-and-groove edges and with one side having grooved drainage channels and faced with manufacturer’s standard, nonwoven geotextile filter fabric.

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Hydrotech, Inc.; ThermaFlo Type 750 or comparable product by one of the following:

   a. DuPont de Nemours, Inc.
   b. Owens Corning.
   c. Kingspan Group.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

B. Extruded Polystyrene Board Insulation, Type VI (INSUL-4): ASTM C578, Type VI, 40-psi (276-kPa) minimum compressive strength.

1. Products: Subject to compliance with requirements, provide one of the following:

a. DuPont de Nemours, Inc.; Styrofoam Brand Highload Extruded Polystyrene Foam Insulation.
b. Owens Corning; Owens Corning FOAMULAR NGX 400 Extruded Polystyrene Insulation.
c. Kingspan Group; GreenGuard.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced (INSUL-15): ASTM C1289, foil faced, Type I, Class 1 or 2. Use behind Brick and Exterior Cladding.

1. Products: Subject to compliance with requirements, provide one of the following:

a. DuPont de Nemours, Inc.; Thermax.
b. Hunter Panels; XCI Foil.
c. Johns Manville; a Berkshire Hathaway company; AP Foil-Faced.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.3 GLASS-FIBER BLANKET INSULATION

A. Verify insulation complies with the 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."

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 35 percent.

C. Glass-Fiber Blanket Insulation, Unfaced (INSUL-40): ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed; SAINT-GOBAIN; CertaPRO AcoustaTherm Batts.
b. Johns Manville; a Berkshire Hathaway company; Formaldehyde-Free and Unfaced Sound Control Batts.
c. Owens Corning; Sound Attenuation Batts.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.

3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.4 MINERAL-WOOL BLANKET INSULATION

A. Verify insulation complies with the 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."

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 35 percent.

C. Mineral-Wool Blanket Insulation, Unfaced (INSUL-24): ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. ROCKWOOL.
    c. Thermafiber Inc.; an Owens Corning company; FS-25.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

D. Mineral-Wool Blanket Insulation, Reinforced-Foil Faced (INSUL-25): ASTM C665, Type III (reflective faced); Class A, faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene with a formed 0.063-inch thick minimum (or as engineered for span and wind load) aluminum backpan with insulation adhered to inner surface of pan. Pan shall be formed to fit spandrel opening and glazed into outer glazing channel behind 1-inch thick spandrel glass / glazed IMP2. Maintain a minimum of 2-inches from back face of glass and face of insulation. Flanges of pan shall be lapped, sealed with sealant and riveted to form interior moisture retarder, conforming to following:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Thermafiber, Inc.; an Owens Corning company; FireSpan 40 or comparable product by one of the following:

    a. Rockwool International; Curtainrock 40.
    b. Johns Manville; a Berkshire Hathaway company.

2. Density: 4 pcf.
3. Thickness: 4-inch, unless otherwise indicated.
4. R-Value: 15 at 4-inches (U-Value 0.06).
5. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
6. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
7. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.
8. Fiber Color: Dark color, unless otherwise indicated.
9. Unless otherwise indicated, provide in 2” thickness.

2.5 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Two-Component Spray Polyurethane Foam Insulation (INSUL-30): Closed cell, with maximum flame-spread and smoke-developed indexes of 25 and 400, respectively, per ASTM E 84. For use at floor/roof and wall junctions and other gaps, cracks, or crevices in the building envelope.

    a. Basis-of-Design Product: DuPont; FROTH-PAK Foam Sealant or comparable product by one of the following;

        1) BASF Corporation.
        2) SWD Urethane; Quik-Shield 118.

3. One-Component Spray Polyurethane Foam Insulation (INSUL 31): Open cell, with maximum flame-spread and smoke-developed indexes of 10 and 20, respectively, per ASTM E 84. For use at sealing gaps around window/door frame and rough opening.

    a. Basis-of-Design Product: DuPont; Great Stuff Pro Window & Door Insulating Foam Sealant or comparable product by one of the following;

        1) BASF Corporation.
        2) SWD Urethane; Quik-Shield 108YM.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

1. Verify adhesives have a VOC content of 70 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

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. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Adhesive Installation: Install with vertical beads of adhesive according to manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL AND RAIN SCREEN INSULATION

A. Foam-Plastic Board Insulation: Install vertical beads of adhesive spaced approximately 24 inches (610 mm) o.c. on inside face and as recommended by manufacturer.

1. Fit courses of insulation between obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.
3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. 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 (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
2. Spray Polyurethane Insulation:

a. Install materials in strict compliance with manufacturer's written installation instructions. Provide thermal barrier as required.
b. Install materials in accordance with manufacturer's instructions and acceptable to authorities having jurisdiction and the Consultant to provide required air seal.
c. Apply sealants within recommended application temperature ranges. Consult manufacturer when sealants cannot be applied within specified ranges.
d. In low humidity, mist area with water to aid cure of one-component sealant.
e. Avoid overfilling restricted spaces.
f. Install foam sealants in accordance with authorities having jurisdiction and all other applicable regulations pertaining to sealing materials.
g. Provide continuity with the air barrier systems by sealing the following areas within the construction and construction assemblies. Please note that these areas are typical in nature and does not limit the application of these products to these noted areas but any and all details within the construction that present similar air leakage characteristics should receive similar applications. Please note the following:

1) Various roof locations including penetrations of all kinds and roof to fascia junctions.
2) Window head, jamb and sill areas at cavity wall.
3) Various roof areas including sloped roof/wall junctions, penetrations of all kinds and roof/wall junctions.
4) Junction of roof air/vapor barrier and wall air/vapor barrier.
5) In cavity wall construction at roof/wall junctions, window perimeters, exhaust vents and soffits.
6) Junctions at roof scuppers and other mechanical equipment located on the roof.
7) Window frame at columns.
8) Curtain wall systems at window and metal panels.
9) At intervals in the cavity wall to achieve compartmentalization.
10) Window frames, and parapets, in stucco wall construction.
11) Exterior soffit overhangs in cavity wall construction.
12) Wall/roof junctions at drain scuppers and other areas where mechanical equipment is located on the roof.
13) Provide reduced air leakage into and out of building (s) by sealing gaps, leaks and holes in interior and exterior construction
14) Ensure continuity of air and vapor seal between wall and window frame in accordance with the requirements of CSA A440.4 Windows standard.
15) Inspect roof perimeter for air leakage paths such as the fluted deck itself, truss and structural beam penetrations above and below the top of the wall, open mortar joints, and conduit and pipe penetrations. Use smoke tester kits to identify and locate leakage.
16) Where deck flutes run perpendicular to the wall, foam the open flutes completely out to the fascia.
17) Where closed flutes occur, punch flutes and inject foam through holes. Locate holes as close to wall as possible so that the plane of injected and

cured foam within the closed flute is level with the plane of the exposed foam in the open flutes.

18) Where the steel deck is parallel to the wall, fill the void.

3.7 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass.
2. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
3. Install insulation to fit snugly without bowing.
4. Fully tape terminations and penetrations with manufacturer’s foil tape for air and vapor control.

3.8 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. 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 072100

SECTION 072119 - FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Closed-cell spray polyurethane foam insulation.
2. Accessories.

B. Related Requirements:

1. Section 072100 "Thermal Insulation" for foam-plastic board insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each product, for tests performed by qualified testing agency.
2. Research Reports: For spray-applied polyurethane foam-plastic insulation, from an agency acceptable to authorities having jurisdiction showing compliance with requirements.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

C. Qualification Statements: For Installer.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION (SPF-1)

A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 2.0 – 2.4 lb/cu. ft. and minimum aged R-value at 1-inch (25.4-mm) thickness of 7.4 deg F x h x sq. ft./Btu at 75 deg F.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Huntsman Building Solutions; HBS Heatlok HFO Pro or a comparable product by one of the following:

    a. BASF Corporation; WALLTITE LWP Series.
    b. Gaco; Holcim Building Envelope.
    c. NCFI Polyurethanes; a division of Barnhardt Manufacturing Company.

2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 450 or less.

3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.2 ACCESSORIES

A. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.

B. Ignition Barrier: Material providing a 15-minute minimum fire-ignition barrier.

1. Ignition Barrier Coating: Fire-protective coating formulated for application over polyurethane foam plastics, compatible with insulation, and in compliance with ICC-ES AC377, Appendix X.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Flame Seal Products, Inc.
        2) International Fireproof Technology Inc.
        3) No-Burn, Inc.
        4) SES Foam LLC.
        5) TPR2 Corporation.

2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 50 or less.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.

B. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.2 INSTALLATION

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Spray insulation to envelop entire area to be insulated and fill voids.

C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.

D. Miscellaneous Voids: Apply according to manufacturer's written instructions.

E. Install ignition barrier material.

1. Do not cover insulation prior to any required spray foam insulation inspections.

F. Apply barrier coatings in accordance with manufacturer's written instructions and to comply with requirements for listing and labeling for fire-propagation characteristics and surface-burning characteristics specified.

1. Use equipment and techniques best suited for substrate and type of material applied as recommended by coating manufacturer.
2. Apply coatings to prepared surfaces as soon as practical after preparation and before subsequent surface soiling or deterioration.
3. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Produce sharp lines and color breaks.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect spray foam insulation installation, including accessories. Report results in writing.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 072119

SECTION 072160 - STRUCTURAL THERMAL BREAK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Structural thermal break locations:

1. Canopies.
2. Shelf angles.
3. Curtain wall mullions and anchors.
4. Façade and cladding connections.
5. Roof penetrations.
6. Fall arrest anchors.
7. Roof posts.
8. Wall to roof transitions.
9. Parapets.
10. Steel beam connections.
11. Steel column base/concrete footings.
12. Concrete slab to steel connections.
13. Window framing.
14. Door thresholds.
15. Foundation to wall transitions.

1.2 RELATED STANDARDS

A. Related Sections include the following:

1. Section 033000 – Cast-in-Place Concrete for coordination with concrete.
2. Section 042000 – Unit Masonry for coordination with masonry construction.
3. Section 051200 – Structural Steel for coordination with structural steel construction.

1.3 REFERENCE STANDARDS

A. American Institute of Steel Construction (AISC):

1. AISC 360 - Specification for Structural Steel Buildings

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):

1. ASHRAE 90.1-2016 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International (ASTM) (www.astm.org):

1. ASTM C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
2. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
3. ASTM D 695 – Standard Test Method for Compressive Properties of Rigid Plastics.
4. ASTM D 696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer.

5. ASTM D 732 – Standard Test Method for Shear Strength of Plastics by Punch Tool.
6. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
7. ASTM D 2863 – Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).

D. Research Council on Structural Connections (RCSC):

1. Specification for Structural Joints Using High Strength Bolts, August 1, 2020.

E. United States Green Building Council (USGBC):

1. LEED v4.1 - Leadership in Energy and Environmental Design for Building Design and Construction.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions.

B. Schedule: Submit a list of locations where structural thermal breaks are to be used, and the specific product and thickness to be used at each location.

C. Manufacturer's Certification: Submit manufacturer's certification that structural thermal breaks comply with specified requirements and are suitable for intended application.

D. Shop Drawings: Submit shop drawings showing details of construction, and relationship of structural thermal break material with adjacent construction including fastening and/or anchorage connection details, thermal break material size and thickness. Submit drawings, indicating:

1. Dimensions, locations, and quantities of structural thermal break plates, structural thermal break washers, and bushings.
2. Size and location of holes in structural thermal break plates.
3. OD and ID for structural thermal break washers and bushings.
4. Connection details, including bolt/anchor and washer sizes.

E. Thermal Design: Wall assembly or interface detail shall meet the ASHRAE 90.1 requirements for continuous insulation and shall not have structural connections (beams, support framing, sub girts, clips) which create thermal bridging. Effective U values of wall, roof and foundation assemblies shall meet or exceed the design requirements per code. Effective U value calculation or modeling shall be performed in accordance with ASHRAE guidelines.

F. Structural Design: Design structural thermal break connections and/or façade attachment support framing using performance requirements and design criteria indicated. Provide comprehensive engineering analysis by a qualified professional engineer.

G. Samples: Submit manufacturer's samples of the following:

1. Structural thermal break: Minimum 2 inches by 2 inches.
2. Thermal break washers.
3. Thermal break bushings.

1.5 WARRANTY

A. Warranty Documentation: Submit manufacturer's standard warranty.

1.6 DESIGN REQUIREMENTS

A. Structural Design: Structural connections using structural thermal break products shall be designed to the applicable AISC, RCSC, ASCE, and local building design codes.

B. Thermal Design: Wall or roof assembly shall meet the prescriptive R-value or performance-based U-value as given in the ASHRAE 90.1 relevant code by state and climate zone. Wall assemblies shall meet the ASHRAE requirement for "continuous insulation" which prohibits thermal bridging.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers and packing, with identification labels intact.

B. Storage and Handling:

1. Comply with manufacturer's recommendations for storage and handling.
2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
3. Store materials in a clean, dry area indoors.
4. Do not store materials directly on the floor or ground.
5. Store materials out of direct sunlight.
6. Keep materials from freezing.
7. Protect materials during storage, handling, and installation to prevent damage.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Climaspec LLC or comparable product by one of the following;

1. Armatherm US.
2. Fabreeka International, Inc.

B. Single Source: Provide structural thermal breaks from single manufacturer.

2.2 STRUCTURAL THERMAL BREAKS (TBM-1)

A. Structural Thermal Break Material: ClimaSpec TB.

1. Description:

a. Structural thermal break material to prevent thermal bridging between building elements.

b. Minimizing energy loss while maintaining structural integrity.

2. Material: Reinforced laminate thermoset.

3. Thickness: As indicated on the Drawings.

4. Ultimate Mechanical Properties, Nominal:

a. Compressive Strength,	ASTM D695:	38,900 psi (268.2 MPa).
b. Tensile Strength,	ASTM D638:	9,400 psi (64.8 MPa).
c. Tensile Modulus,	ASTM D638:	1.7 x 10^6 psi (11,721.0 MPa).
d. Flexural Strength,	ASTM D790:	22,300 psi (153.7 MPa).
e. Shear Strength,	ASTM D732:	13,400 psi. (92.3 MPa).

5. Flame Resistance, Nominal:

a. Oxygen Index,	ASTM D 2863:	21.8 percent.

6. Thermal Properties, Nominal:

a. Thermal Conductivity, ASTM C177: 1.8 BTU/hr/ft^2/in/degree F (0.259 W/m* degree K).
b. Coefficient of Thermal Expansion, ASTM D696: 2.2 in/in/degree C x10^{-5}.

2.3 ACCESSORIES

A. Thermal Break Washers: “ClimaSpec Washers”.

1. Material: Same material as “ClimaSpec TB” structural thermal break.
2. Thickness 1/4 inch (6.4mm).
3. OD and ID: Determined by the bolt/anchor diameter. Refer to manufacturer’s washer and bushing size data.

B. Thermal Break Bushings: “ClimaSpec Bushings”

1. Material: Glass-reinforced laminate
2. Length: Determined by thickness of steel end plate.
3. OD and ID: Determined by the bolt/anchor diameter. Refer to manufacturer’s washer and bushing size data.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine locations to secure structural thermal breaks.

B. Confirm locations to receive structural thermal breaks are clean, dry, flat, and undamaged.

C. Notify the Architect of conditions that would adversely affect installation or subsequent use.

D. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

A. General:

1. Install structural thermal breaks in accordance with manufacturer's instructions at locations indicated in the approved design.
2. Identify correct structural thermal break as indicated on the Drawings.
3. Install correct sizes of structural thermal breaks, thermal break washers, and thermal break bushings as indicated on the Drawings.
4. When required install hardened USS Grade 8 flat washers on both sides of thermal break washers in accordance with Structural Engineer's instructions.

    1. Steel Washer OD: Greater than or equal to thermal break washer OD.

5. When required install thermal break bushings into oversized building element holes to accept OD of bushings.

B. Bolted Structural Steel Connections:

1. Install bolted structural steel connections as specified in Section 051200. 1. Bolt torque values are provided by the Structural Engineer and are determined by required clamping force, proper tension of bolts, and long-term creep.

3.3 ADJUSTING

A. Remove and replace with new material, damaged components that cannot be successfully repaired, as determined by the Architect or Structural Engineer.

3.4 PROTECTION

A. Protect installed structural thermal break connection from damage during construction.

END OF SECTION 072160

SECTION 072726.04 – FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fluid-applied, vapor-impermeable membrane air barriers.

1.2 RELATED REQUIREMENTS

1. Division 01 Section "Sustainable Design Requirements" for additional requirements, including LEED documentation requirements.
2. Section 042000 "Unit Masonry" for air barrier substrates and compatibility with flashing components.
3. Section 061600 "Sheathing" for air barrier substrates and joint treatments.
4. Division 07 Roofing Sections for roof assembly air barriers and interface coordination.
5. Division 08 Exterior Openings sections for framing for aluminum-framed entrances, glazed aluminum curtain walls, and louvers receiving air barrier transition assembly specified in this Section.

1.3 REFERENCES

A. References, General: Versions of the following cited standards current as of the date of issue of the project apply to the Work of this Section.

B. ASTM International (ASTM): www.astm.org:

1. ASTM A 240/A 240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
2. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants
3. ASTM C 1193 - Guide for Use of Joint Sealants
4. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
5. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials
6. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials
7. ASTM E 162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
8. ASTM E 783 - Standard Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors
9. ASTM E 1186 - Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
10. ASTM E 2178 - Standard Test Method for Air Permeance of Building Materials
11. ASTM E 2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

C. UL Environment Greenguard Certification: www.greenguard.org

1. Greenguard Certification Product Guide

D. National Fire Protection Association (NFPA): www.nfpa.org:

1. NFPA 285 - Standard Fire Test Method For Evaluation Of Fire Propagation Characteristics Of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

E. U. S. Environmental Protection Agency (EPA): www.epa.gov:

1. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings

F. US Green Building Council (USGBC): www.usgbc.org:

1. Leadership in Energy and Environmental Design (LEED) Green Building Rating System

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of joint sealants with cleaning of joint sealant substrates and other operations that may impact installation or finished joint sealant work.

B. Preinstallation Conference: Conduct conference at Project Site.

1. Review requirements for air barrier products and installation, project and manufacturer's details, mockups, testing and inspection requirements, and coordination and sequencing of air barrier work with work of other Sections.
2. Review manufacturer's instructions for air barrier application meeting Project requirements for substrates specified, including three-dimensional video model demonstrating proper application of components at wall openings.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of air barrier product specified, including:

1. Technical data indicating compliance with requirements.
2. Substrate preparation instructions and recommendations.

B. LEED Submittals:

1. LEED NC Credit IEQ 4.1: Product data for air barrier components applied inside the weather envelope. Including statement of VOC content.

C. Shop Drawings: Project specific. Show locations for air barrier. Show details for each type of substrate, joints, and edge conditions, including flashings, counterflashings, penetrations, transitions, and terminations. Include transitions to adjacent exterior enclosure assemblies (e.g. windows/doors, roof, waterproofing, and below-grade waterproofing.

1. Show location of transition and accessory materials providing connectivity through out the assemblies.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

1. Certification of manufacturer's approval of Installer.

B. Manufacturer's Product Compatibility Certificate: Certify compatibility of air barrier products with adjacent materials.

C. Fire Propagation Characteristics Certificate: From a qualified testing agency, documentation that air barrier system as a component of a wall assembly has been tested and passed NFPA 285. Include system classification number of testing agency on shop drawings.

D. Product Test Reports: Test data for air barrier products and air barrier assembly, by qualified testing agency, indicating proposed membrane air barrier meets performance requirements, when requested by Architect.

E. Warranty: Sample of unexecuted manufacturer and installer special warranties.

F. Field quality control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm with minimum three years experience in installation of specified products in successful use on similar projects, employing workers trained by manufacturer, including a full-time on-site supervisor with a minimum of three years experience installing similar work, able to communicate verbally with Contractor, Architect, and employees.

B. Manufacturer Qualifications: A qualified manufacturer listed in this Section with minimum five years experience in manufacture of air barrier membrane as one of its principal products.

1. Manufacturer's product submitted has been in satisfactory operation on five similar installations for at least five years.

C. Mockups: Provide air barrier mockup application within mockups required in other sections, or if not specified, in an area of not less than 150 sq. ft. (14 sq. m) of wall surface where directed by Architect for each type of backup wall construction. Include examples of surface preparation, crack and joint treatment, air barrier application, and flashing, transition, and termination conditions, to set quality standards for execution.

1. Include intersection of wall air barrier with roof air barrier and with foundation wall intersection.

1.8 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in manufacturer's unopened original packaging.

B. Store products in weather protected environment, clear of ground and moisture, within temperature ranges recommended by air barrier manufacturer.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.
2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

1.10 SCHEDULING

A. Coordinate installation of membrane air barrier with completion of roofing and other work requiring interface with air barrier.

B. Schedule work so air barrier applications may be inspected prior to concealment.

C. Ensure air barrier materials are cured before covering with other materials.

1.11 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which air barrier manufacturer agrees to furnish and install air barrier material to repair or replace those materials installed according to manufacturer's written instructions that exhibit material defects or otherwise fail to perform as specified under normal use within warranty period specified.

1. Access for Repair: Owner shall provide unimpeded access to the Project and the air barrier system for purposes of testing, leak investigation, and repair, and shall reinstall removed cladding materials upon completion of repair.
2. Cost Limitation: Manufacturer's obligation for repair or replacement shall be limited to the original installed cost of the work.
3. Warranty Period: Five years from date of Substantial Completion.

B. Special warranties specified in this article exclude deterioration or failure of air barrier materials from the following:

1. Movement of the structure caused by structural settlement or stresses on the air barrier exceeding manufacturer's written specifications for elongation.
2. Mechanical damage caused by outside agents.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain air-barrier materials from single source from single manufacturer.

B. VOC Content: 250 g/L maximum per 40 CFR 59, Subpart D (EPA Method 24) and complying with requirements of authorities having jurisdiction.

C. Compatibility: Provide membrane air barrier materials that are compatible with one another and with adjacent materials under conditions of service and application required, as demonstrated by membrane air barrier manufacturer based on testing and field experience.

2.2 PERFORMANCE REQUIREMENTS

A. General: Membrane air barrier shall be capable of performing as a continuous vapor-impermeable air barrier and as a moisture drainage plane transitioned to adjacent flashings and discharging water to the building exterior. Membrane air barriers shall accommodate substrate movement and seal expansion and control joints, construction material transitions, opening transitions, penetrations, and perimeter conditions without moisture deterioration and air leakage exceeding performance requirements.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E 2357.

C. Fire Propagation Characteristics: Provide air barrier system qualified as a component of a comparable wall assembly that has been tested and passed NFPA 285.

2.3 MEMBRANE AIR BARRIER (AB-1)

A. Fluid-Applied, Vapor-Impermeable Membrane Air Barrier: Elastomeric, UV-resistant, synthetic membrane, formulated for application in a range of 80 mils (wet), 40 mils (dry).

1. Basis of Design Product: Subject to compliance with requirements, provide Tremco, Inc., ExoAir 130 or a comparable product by one of the following;

   a. Carlisle Coatings & Waterproofing, Inc.; Fire Resist Barritech NP.
   b. GCP Applied Technologies, Inc.; PERM-A-BARRIER NPL 10.
   c. Henry Company; Air-Bloc ~~*32*~~*16MR*.
   d. W.R. Meadows, Inc; AIR-SHIELD LSR.

2. Air Permeance, ASTM E 2178: 0.004 cfm/sq. ft of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference, maximum.
3. Vapor Permeance, ASTM E 96/E96M: Less than 0.1 perms (5.8 ng/Pa x s x sq. m).
4. Elongation, Ultimate, ASTM D 412, Die C: 200 percent, minimum.
5. UV Resistance, QUV-B: Over 160 cycles of UV and water spray with no observable deterioration.
6. VOC Content: Less than 50 g/L.

2.4 ACCESSORY MATERIALS

A. General: Accessory materials as described in manufacturer's written installation instructions, recommended to produce complete air barrier assembly meeting performance requirements, and compatible with air barrier membrane material and adjacent materials.

B. Primer: Liquid primer meeting VOC limitations, recommended for substrate by membrane air barrier manufacturer, when installing modified bituminous self-adhered membranes.

1. Basis of Design Product: Tremco, Inc., ExoAir Primer.

C. Transitions:

1. Counterflashing Strip: Modified bituminous, 40 mils (1.0 mm) thick self-adhering composite sheet consisting of 32 mils (0.8 mm) of SBS rubberized asphalt laminated to an 8 mils (0.2 mm) high-density, cross-laminated polyethylene film, for counterflashing of metal flashings and for substrate transitions and for termination of air barrier to bituminous roof membranes and to air barrier terminations at openings.

   a. Basis of Design Product: Tremco, Inc., ExoAir TWF Thru-Wall Flashing.

2. High Temperature Flashing Strip and Underlayment: Butyl, 24 mil thick self-adhering composite sheet consisting of 20 mils of butyl laminated to 4 mil polyethylene film; thermally stable under intermittent, non-continuous exposure up to 240 deg F (115 deg C).

   a. Basis of Design Product: Tremco, Inc., ExoAir 110AT.

3. Foil Flashing Strip: Butyl, 22 mil thick self-adhering composite sheet consisting of 16 mils of butyl laminated to 6 mil polyethylene film; thermally stable under intermittent, non-continuous exposure up to 240 deg F (115 deg C
4. Opening Transition Assembly: Cured low-modulus silicone extrusion, with reinforcing ribs, sized to fit opening widths, with the following characteristics:

a. Basis of Design Product: Tremco, Inc., Proglaze ETA Engineered Transition Assembly. Tear Strength: 110 lb/in (19.3 kN/m).

5. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with manufacturer's recommended silicone sealant for bonding extrusions to substrates.

a. Basis of Design Product: Tremco, Inc.; Spectrem SimpleSeal.

D. Reinforcing Fabric: High strength mesh fabric consisting of open-weave glass fiber saturated with synthetic resins formulated for high moisture resistance, for reinforcing of liquid applications; not less than 2.5 oz/sq. yd (85 g/sq. m).

1. Basis of Design Product: Tremco, Inc., Tremco 2011.

E. Liquid Joint Sealants:

1. ASTM C 920, single-component polyurethane, approved by air barrier manufacturer for adhesion and compatibility with membrane air barrier and accessories.

a. Basis of Design Product: Tremco, Inc., Dymonic 100.

2. ASTM C 920, single-component, neutral-curing silicone, approved by air barrier manufacturer for adhesion and compatibility with membrane air barrier and accessories post installation of the membrane.

a. Basis of Design Product: Tremco, Inc., Spectrem 1.

F. Sprayed Polyurethane Foam Sealant: Sprayed Polyurethane Foam Sealant: Foamed-in-place, 1.5- to 2.0-lb/cu. ft. (24- to 32-kg/cu. m) density, with flame-spread index of 25 or less per ASTM E 162, for filling of gaps at openings and penetrations.

1. Basis of Design; Tremco Inc., Flexible Low Expanding Foam (LEF)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Surface Condition: Before applying air barrier materials, examine substrate and conditions to ensure substrates are fully cured, smooth, clean, dry, and free from high spots, depressions, loose and foreign particles and other deterrents to adhesion, and conditions comply with manufacturer's written recommendations.

1. Verify concrete and masonry surfaces are visibly dry, have cured for time period recommended by membrane air barrier manufacturer, and are free from release agents, curing agents, and other contaminates.
2. Test for capillary moisture by method recommended in writing by air barrier manufacturer.
3. Verify masonry joints are filled with mortar and struck flush.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INTERFACE WITH OTHER WORK

A. Commencement of Work: Commence work once air barrier substrates are adequately protected from weather and will remain protected during remainder of construction.

B. Sequencing of Work: Coordinate sequencing of air barrier work with work of other sections that form portions of building envelope air barrier to ensure that flashings and transition materials can be properly installed and inspected. Roofing systems shall be capped and sealed, or top of walls protected, in such a way as to eliminate the ability of water to saturate the wall or interior space, both before and after, air barrier system installation. Coordinate installation of EXOAIR® 230 with the roofing trade to ensure compatibility and continuity with the roofing system.

C. Subsequent Work: Coordinate air barrier work with work of other sections installed subsequent to air barrier to ensure complete inspection of installed air barrier and sealing of air barrier penetrations necessitated by subsequent work.

3.3 PREPARATION

A. Clean, prepare, and treat substrate in accordance with air barrier manufacturer's written instructions.

1. Mask adjacent finished surfaces.
2. Remove contaminants and film-forming coatings from substrates.
3. Remove projections and excess materials and fill voids with substrate patching material.
4. Prepare and treat joints and cracks in substrate per ASTM C 1193 and membrane air barrier manufacturer's written instructions.

3.4 APPLICATION OF ACCESSORY MATERIALS

A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions. Install transition materials and other accessories to form connect and seal membrane air barrier material to adjacent components of building air barrier system, including, but not limited to, roofing system air barrier, exterior fenestration systems, door framing, and other openings.

B. Primer: Apply primer to substrates when recommended by air barrier manufacturer at required rate for those substrates that will be receiving a modified bituminous self-adhered membrane. Reprime areas not covered within 24 hours.

C. Assembly Transitions: Connect and seal exterior wall air barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

1. Opening Transitions: Fill gaps at perimeter of openings with foam sealant and apply approved transition or accessory material
2. Penetrations: Fill gaps at perimeter of penetrations with foam sealant and level with approved sealant. or seal transition strips around penetrating objects and terminate with approved sealant.
3. Joints: Bridge and cover isolation joints, expansion joints, and discontinuous joints between separate assemblies utilizing approved transition or accessory materials.
4. Changes in Plane: Apply approved sealant beads at corners and edges to form smooth transition.

5. Substrate Gaps: Cover gaps with stainless steel sheet mechanically attached to substrate and providing continuous support for air barrier.

D. Flashings: Seal top of through-wall flashings to membrane air barrier with a continuous bead of approved sealant recommended by air barrier manufacturer.

E. Seal punctures, voids, and seams. Patch with approved transition and accessory materials following air barrier manufacturer's recommendations and extend repair beyond repaired areas to maintain continuity.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

A. General: Apply fluid air-barrier material to form a seal with transition materials and accessories to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.

B. Membrane Air Barrier: Apply fluid air barrier material in full contact with substrate to produce a continuous seal according to membrane air barrier manufacturers written instructions.

1. Vapor-Impermeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, 40 dry film thickness depending on substrate, applied in one or more equal coats, roller- or spray- applied.

C. Connect and seal exterior wall air-barrier membrane continuously to subsequently-installed roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, wall openings, and other construction used in exterior wall openings, using approved transitions and accessory materials.

D. Wall Openings: Apply approved sealant to adhere silicone extrusion to perimeter of windows, curtain walls, storefronts, doors, and louvers. Apply opening transition assembly according to air barrier transition manufacturer's written instructions.

E. Seal punctures, voids, and seams. Patch with approved transition and accessory materials following air barrier manufacturer's recommendations and extend repair beyond repaired areas to maintain continuity.

F. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

H. All cladding girts, anchors and similar items that penetrate the air/vapor barrier membrane must be sealed air/water tight per the manufacturer's requirements.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections. Refer to Section 019117 "Building Enclosure Functional Performance Testing" for additional requirements.

B. Coordination of Testing: Cooperate with testing agency. Allow access to work areas and staging. Notify testing agency in writing of schedule for Work of this Section to allow sufficient time for testing and inspection.

1. Do not cover Work until testing and inspection is completed and accepted.

C. Reporting: Forward written inspection reports to the Architect within 10 working days of the inspection and test being performed.

D. Correction: Correct deficient applications not passing tests and inspections, make necessary repairs, and retest as required to demonstrate compliance with requirements.

3.7 CLEANING AND PROTECTING

A. Clean spills, stains, and overspray resulting application utilizing cleaning agents recommended by manufacturers of affected construction. Remove masking materials.

B. Protect membrane air barrier from damage from subsequent work. Protect membrane materials from exposure to UV light for period in excess of that acceptable to membrane air barrier manufacturer; replace overexposed materials and retest.

END OF SECTION 072726.04

SECTION 074213.13 – FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Exposed fastener metal wall panels, as part of the assembly described in Section 2.1.

1.2 RELATED REQUIREMENTS

A. Division 01 Section "Sustainable Design Requirements" for related requirements.

B. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal copings, flashings, reglets and roof drainage items.

C. Division 07 Section "Joint Sealants" for field-applied joint sealants.

1.3 REFERENCES

A. American Architectural Manufacturer's Association (AAMA):

1. AAMA 620 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates.

B. American Society of Civil Engineers (ASCE):

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

C. ASTM International (ASTM):

1. ASTM B 209 - Specification for Aluminum and Aluminum Alloy Sheet and Plate.
2. ASTM C 754 - Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.
3. ASTM C 920 - Specification for Elastomeric Joint Sealants.
4. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
5. ASTM E 283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
6. ASTM E 331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

D. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):

1. Architectural Sheet Metal Manual.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide metal wall panel assemblies meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.

B. Air Infiltration: When installed over Insulated Composite Backup Panels, maximum 0.06 cfm/sq. ft. (0.3 L/s per sq. m) per ASTM E 283 at a static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.

C. Water Penetration, Static Pressure: When installed over Insulated Composite Backup Panels, no uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 6.24 lbf/sq. ft. (299 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.

D. Maximum allowable deflection limitation.

1. Single Skin Panels greater than 1-inch (25-mm) in Depth: Limited to L/120 deflection of panel perimeter normal to plane of wall.

E. Secondary Metal Framing: Design secondary metal framing for metal wall panel assembly according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

F. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.

G. Wall systems that incorporate foam plastic insulation must be tested by the foam plastic supplier in accordance with NFPA-285.

1.5 QUALITY ASSURANCE

A. Manufacturer/Source: Provide metal wall panel and panel accessories from a single manufacturer.

B. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum 10 years experience in manufacture of similar products in successful use in similar applications.

C. Wall Systems Installer Qualifications: Experienced Installer with minimum of 5 years experience with successfully completed projects of a similar nature and scope.

1.6 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's representative, and other trade contractors.

1. Coordinate building framing in relation to metal wall panel assembly.
2. Coordinate installation of building air and water barrier behind metal wall panel assembly.
3. Coordinate window, door and louver, and other openings and penetrations of metal wall panel assembly.

1.7 ACTION SUBMITTALS

A. Product Data: Manufacturer’s data sheets, for specified products.

1. Include data indicating compliance with performance requirements.

B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized Installer. Include full elevations showing openings and penetrations. Include details

of each condition of installation and attachment. Provide details at a minimum scale 1-1/2-inch per foot (1:8) of all required trim and extrusions needed for a complete installation.

1. Indicate points of supporting structure that must coordinate with metal wall panel assembly installation.

C. Samples for Initial Selection: For each product specified. Provide representative color charts of manufacturer's full range of colors.

D. Samples for Verification: Provide 12-inch (300 mm) section of panel(s) showing finishes. Provide 12-inch (300 mm) long pieces of trim pieces and other exposed components.

1.8 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.

B. Qualification Information: For Installer firm.

C. Manufacturer's warranty: Submit sample warranty.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect metal wall panel products during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.

1. Deliver, unload, store, and erect metal wall panel products and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.

1.11 WARRANTY

A. Special Manufacturer’s Warranty: On manufacturer’s standard form, in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials and workmanship within two years from date of Substantial Completion.

B. Special Panel Finish Warranty: On manufacturer’s standard form, in which manufacturer agrees to repair or replace metal wall panels that display evidence of deterioration of finish within 20 years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Metal Wall Panels over Outside-Insulated Framed Wall System: Single-skin exposed fastener metal wall panels applied as exterior rainscreen cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing" with exterior sheathing specified in Division 06 Section "Sheathing", an applied membrane that provides air, moisture, and water vapor control

specified in Division 07 Section "Fluid-Applied Membrane Air Barriers", and insulation applied outboard of the sheathing specified in Division 07 Section "Thermal Insulation." Metal wall panel installation specified in this Section includes secondary metal subgirt framing for panel attachment.

B. Metal Wall Panels over Uninsulated Framed Screen Wall System: Single-skin exposed fastener metal wall panels applied as exterior barrier cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing". Metal wall panel installation specified in this Section may include secondary metal subgirt framing for panel attachment.

2.2 MANUFACTURERS

A. Basis of Design Product: Subject to compliance with requirements, provide CENTRIA, a Nucor Brand; Exposed Fastener Series Metal Wall Panels BR5-36 or comparable product approved by one of the following;

1. Elevate; Holcim Building Envelope.
2. PAC-CLAD; Petersen; a Carlisle company.

2.3 METAL WALL PANEL MATERIALS

A. Aluminum Face Sheet: Smooth surface coil-coated, ASTM B 209, 3003-H14 or 5052-H32 alloy.

1. Face Sheet: 0.050 inch (1.27 mm) nominal thickness.
2. Surface: Smooth.

2.4 EXPOSED FASTENER PROFILE METAL WALL PANELS

A. Metal Wall Panels, General: Factory-formed, Exposed fastener panels with interconnecting side joints, fastened to supports with exposed fasteners, with field-applied sealants in side laps when required to meet performance requirements.

B. Ribbed profile with lap joint (MP-4):

1. Basis of Design Product: CENTRIA, BR5-36.
2. Panel Coverage: 36 inches (914 mm).
3. Panel Height: 1.50 inches (38 mm).
4. Rib Spacing: 5 at 7.20 inches (183 mm) o.c.

A. Exposed Coil-Coated Finish System:

1. Fluoropolymer Three-Coat System: 0.8 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, and a 0.8 mil 70 percent PVDF fluoropolymer clear coat, AAMA 621 & 2605.

a. Basis of Design: CENTRIA Duragard Plus.

B. Color:

1. Exterior Surface: Custom color to match MP-2.

2.5 METAL WALL PANEL ACCESSORIES

A. Metal Wall Panel Accessories, General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Fabricate accessories in accordance with SMACNA Manual. Provide manufacturer's factory-formed clips, shims, flashings, gaskets, lap strips, closure strips, and caps for a complete installation as required for the following:

1. Single-skin application over metal framing and secondary framing.
2. Single-skin application over insulated, sheathed frame wall with air and water resistant barrier.

B. Extruded Trim: Manufacturer's complementary aluminum extrusions for head, jamb, sill, base, flush, reveal, inside and outside corner, end wall, and expansion joint details. Finish to match metal wall panels.

1. Basis of Design: CENTRIA, Microline Extrusions.

C. Mitered Corners: Structurally-bonded horizontal interior and exterior trimless corners matching metal wall panel material, profile, and factory-applied finish, fabricated and finished by metal wall panel manufacturer.

1. Welded, riveted, fastened, or field- fabricated corners do not meet the requirements of this specification.
2. Basis of Design: CENTRIA, MicroSeam Corners.

D. Formed Flashing and Trim: Match material, thickness, and color of metal wall panel face sheets.

E. Sealants: Type recommended by metal wall panel manufacturer for application, meeting requirements of Division 07 Section "Joint Sealants."

F. Flashing Tape: 4-inch wide self-adhering butyl flashing tape.

G. Fasteners: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. All exposed fasteners must be stainless steel with heads matching color of metal wall panels by means of factory-applied coating.

2.6 SECONDARY METAL FRAMING

A. Miscellaneous Framing Components, General: Cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z180).

1. Hat Channels: 0.06 inch/16 ga. (1.52 mm) minimum – nominal thickness.
2. Sill Channels: 0.06 inch/16 ga. (1.52 mm) minimum – nominal thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine metal wall panel substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal wall panels.

B. Wall Substrate: Confirm that wall substrate is within tolerances acceptable to metal wall panel system manufacturer.

1. Maximum deviations acceptable:

a. 1/4-inch in 20 feet (6.4 mm in 6 m) vertically or horizontally from face plane of framing.
b. 1/2-inch (12.7 mm) across building elevation.
c. 1/8-inch in 5 feet (3.2 mm in 1.5 m).

C. Framing: Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal wall panels.

D. Openings: Verify that windows, doors, louvers and other penetrations match layout on shop drawings.

E. Air/Moisture Barriers: Confirm that work has been completed, inspected, and tested as required.

F. Advise G.C, in writing, of out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.

G. Correct out of tolerance work and other deficient conditions prior to panel installation.

3.2 SECONDARY FRAMING INSTALLATION

A. Secondary Metal Framing: Install secondary metal framing components to tolerances indicated, as shown on approved shop drawings. Install secondary metal framing and other metal panel supports per ASTM C 1007 and metal wall panel manufacturer's recommendations.

3.3 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place.

B. Attach panels to metal framing using recommended screws, fasteners, sealants, and adhesives indicated on approved shop drawings.

1. Fasteners for Steel Wall Panels: Stainless-steel for exterior locations and locations exposed to moisture; carbon steel for interior use only.
2. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
3. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

C. Joint Sealers: Install joint sealants where indicated on approved shop drawings.

3.4 ACCESSORY INSTALLATION

A. General: Install metal wall panel accessories with positive anchorage to building. Coordinate installation with flashings and other components.

1. Install related flashings and sheet metal trim per requirements of Division 07 Section "Sheet Metal Flashing and Trim."
2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, lap strips, flashings, sealants, fillers, closure strips, and similar items.
3. Comply with performance requirements and manufacturer's written installation instructions.
4. Set units true to line and level as indicated.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a service representative authorized by metal wall panel manufacturer to inspect completed installation. Submit written report.

B. Correct deficiencies noted in manufacturer's report.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.

B. Replace damaged panels and accessories that cannot be repaired by finish touch-up or minor repair.

END OF SECTION 074213.13

SECTION 074213.23 - METAL COMPOSITE MATERIAL WALL PANELS

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. Metal composite material (MCM) panels.
2. Metal composite material (MCM) system.

B. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 070543.11 Composite Metal Hybrid (CMH) Continuous Insulation Sub-Framing Support Systems.
3. Section 019115 "Building Enclosure Commissioning."

1.3 DEFINITIONS

A. DBVC: Drained and back-ventilated cavity rainscreen system designed to drain and dry water entering cavity through drainage channels, weeps, and air ventilation.

B. MCM: Metal composite material; cladding material formed by joining two thin metal skins to polyethylene or fire-retardant core and bonded under precise temperature, pressure, and tension.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, MCM system Installer, MCM system manufacturer's representative, and installers whose work interfaces with or affects MCM 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 MCM system 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 affect MCM system.

6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for system assembly during and after installation.
8. Review procedures for repair of panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

A. Product Data: Include construction details, manufacturer's installation instructions, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel, system, and accessory.

1. Metal composite material (MCM) panels.
2. Metal composite material (MCM) system.

B. Shop Drawings: Submit project specific shop drawings prepared by, or under supervision of, Structural Design Engineer as specified in Quality Assurance article below and including Structural Design Engineer's stamp or seal on all shop drawings including system attachments and anchors.

1. Include fabrication and installation layouts of MCM system; project specific details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, accessories, and special details. Include details showing integration of metal composite material wall panel system with air barrier system such as back-sealing of fastener penetrations. Include integration with adjacent construction.
2. Accessories: Include project specific details of flashing, trim, and anchorage, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
3. Provide signed and sealed drawings, by a qualified design professional in Project jurisdiction, of MCM system showing compliance with performance requirements and design criteria identified for this Project.

C. Samples for Initial Selection: For each type of MCM panel indicated, with factory-applied color finishes.

1. Size: Manufacturers' standard size.
2. Include Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of MCM panel and MCM system required, with factory-applied color finishes.

1. MCM Panel: Manufacturers' standard size.
2. MCM System: 12 inches (305 mm) long by actual panel width, fabricated into panel systems indicated. Include fasteners, closures, and other MCM panel accessories. Panel sample need not be provided in the specified color.

E. Delegated Design Submittals: For MCM system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

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. Test and Evaluation Reports:

1. Product Test Reports: For each MCM system, for tests performed by qualified testing agency.

    a. MCM Panel Manufacturer's Material Test Reports: Certified test reports showing compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.
    b. Fabricator's MCM System Test Reports: Certified test reports showing system compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.

        1) DBVC System: Tested to AAMA 509.

2. Research Reports: For MCM systems, from ICC-ES showing compliance with .

C. Field Quality-Control Submittals:

1. Field quality-control reports.

D. Qualification Statements: For manufacturer, fabricator, Installer and testing agency.

E. Delegated design engineer qualifications.

F. Sample warranties.

G. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For MCM panels.

B. Warranty Documentation:

1. Manufacturers' special warranties.
2. Installer's special warranties.

1.8 QUALITY ASSURANCE

A. Single Source Responsibility: Furnish each product from one manufacturer, unless otherwise acceptable to Architect.

B. Manufacturer Qualifications: Minimum 5 years' experience. Provide representation by manufacturer's field representative during construction and provide written acceptance of installer and fabricator.

C. Fabricator Qualifications: An entity specializing in fabrication of specified metal composite material wall panel components as indicated for installation as part of this project and who is acceptable to metal composite material wall panel manufacturer. Fabricator shall meet the standards of the Premium MCM Fabricator Certification program and be certified by Metal Construction Association (MCA) as a Premium MCM Fabricator.

D. Installer Qualifications: An entity specializing in installation of metal composite material wall panel systems that employs installers and supervisors who are trained, licensed, certified and approved by manufacturer.

E. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

F. Testing Agency Qualifications: An agency acceptable to authorities having jurisdiction.

1.9 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup as indicated on Drawings, including corner, soffits, supports, attachments, and accessories. Include integration with adjacent construction. Refer to Section 014339 "Mockups" for additional requirements.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, MCM panels, and other manufactured items so as not to be damaged or deformed. Package MCM panels for protection during transportation and handling.

B. Unload, store, and erect MCM panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack MCM panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store MCM panels to ensure dryness, with positive slope for drainage of water. Do not store MCM panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on MCM panels during installation.

E. Zinc Panels: Wear gloves and long sleeves when handling to prevent fingerprints and soiling of surface.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of MCM panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

B. Field Measurements: Take field measurements prior to completion of shop fabrication of metal composite material wall panels. Coordinate panel fabrication schedule with construction progress schedule as established by Contractor to avoid delay in construction.

C. Field Modifications: Metal composite material wall panels may be modified in field as required to ensure proper fit as acceptable to panel manufacturer and Architect. Keep field modifications to absolute minimum, ensuring majority of fabrication accomplished under manufacturer and fabricator-controlled conditions.

1.12 COORDINATION

A. Coordinate MCM panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

B. Coordinate metal composite material panel system installation in manner to ensure integrity of air barrier system is not disrupted. Provide monitoring and inspection of metal composite material panel system installation by air barrier system installer and manufacturer’s representative.

1.13 WARRANTY

A. Panel Integrity Warranty: Manufacturer agrees to repair or replace components of MCM panels 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: 10 years from date of Substantial Completion.

B. Panel Finish Warranty: Manufacturer agrees to repair finish or replace MCM 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 in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. MCM System Warranty: System manufacturer's standard form in which manufacturer agrees to repair or replace components of MCM systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Metal-faced composite 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-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 15 percent.

D. Structural Performance: MCM systems to withstand the effects of the following loads, based on testing in accordance with ASTM E330/E330M:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

E. Provide DBVC system with V-axis classification number greater than or equal to W-axis classification number in accordance with AAMA 509.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

G. Fire Propagation Characteristics: MCM system passes NFPA 285 testing.

H. Air and Vapor Barrier: Where penetrations are to be made in the air and vapor barrier, provide testing or demonstrate how this system will maintain the integrity of the air and vapor barrier.

2.2 METAL COMPOSITE MATERIAL (MCM) WALL PANELS

A. Metal Composite Material (MCM) Wall Panels: Provide MCM panels fabricated from two metal facings bonded to a solid, extruded thermoplastic core. Provide system where panels anchored to supporting construction without exposed fasteners.

1. Basis-of-Design Product (MP-1): Subject to compliance with requirements, provide ALPOLIC Materials; Mitsubishi Chemical Composites; ALPOLIC/fr Natural Metals Series or a comparable product by one of the following:

    a. ALUCOBOND; 3A Composites USA, Inc.; ALUCOBOND PLUS.
    b. Arconic; Reynobond.
    c. ACMpanelworx.

2. Basis-of-Design Product (MP-2, MP-3): Subject to compliance with requirements, provide ALUCOBOND; 3A Composites USA, Inc.; ALUCOBOND PLUS Route & Return or a comparable product by one of the following:

    a. Arconic; Reynobond.
    b. Mitsubishi Chemical Composites; ALPOLIC.
    c. ACMpanelworx.

3. Core: FR.
4. Panel Thickness: 0.157 inch (4 mm).
5. Bond Strength: 22.5 in-lb/in. (100 N x mm/mm) when tested for bond integrity in accordance with ASTM D1781.

B. MCM Panel Materials:

1. Zinc-Faced Panels (MP-1): ASTM B69 with 0.020-inch- (0.50-mm-) thick, zinc sheet facings.

    a. Exterior Finish: ALPOLIC Natural Metal Series, Zinc Metal Plate; VM ZINC Quartz Natural Zinc Finish.

2. Aluminum-Faced Panels (MP-2, MP-3): ASTM B209/B209M alloy as standard with manufacturer, temper as required to suit finish and forming operations with 0.020-inch- (0.50-mm-) thick, aluminum sheet facings.

    a. Exterior Finish: Two-coat metallic fluoropolymer.

        1) Color (MP-2): Light Gray, Beachstone Gray Metallic.
        2) Color (MP-3): Dark Gray, *Basalt Gray*.

2.3 METAL COMPOSITE MATERIAL (MCM) SYSTEM

A. DBVC MCM System: Provide factory-formed and -assembled, MCM panels formed into profile for DBVC system installation, drained at horizontal joints and at base of wall. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.

B. System Panel Depth: As indicated on drawings.

C. Attachment Assembly Components: Manufacturer's standard formed from material compatible with panel facing.

D. Labeling: Comply with labeling requirement of applicable building code.

2.4 ACCESSORIES

A. Metal Subframing and Furring: ASTM C955 cold-formed, metallic-coated steel sheet ASTM A653/A653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard non-conductive sections as required for support and alignment of MCM system.

B. System Accessories: Provide components required for a complete, weathertight wall system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, backer plates and similar items. Match material and finish of MCM panels unless otherwise indicated.

C. Backer plates: Provide metal backing plates at panel edges, terminations, openings, splices, and where recommended by manufacturer, consisting of Zinc Plus or stainless steel sheet goods formed in configuration and thickness recommended by manufacturer.

D. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels 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 MCM panels.

E. Panel Sealants: ASTM C920; silicone sealant; of type, grade, class, and use classifications required to seal joints at adjacent materials, flashings, copings, etc. and remain weathertight; and as recommended in writing by MCM system manufacturer. Color to match panel.

2.5 FABRICATION

A. Composite Panel Fabricators.

1. Approved Fabricators:

   a. Royalton Architectural Fabrication, Inc.
   b. Sobotec, Ltd., Ontario, Canada.
   c. East Coast Metal Systems.
   d. Universe Corporation.
   e. Architectural Metals North America (AMNA).
   f. Tremco CPG Inc.

B. Fabricate and finish MCM panels at the factory, by panel manufacturer's standard procedures and processes, as necessary to fulfill indicated panel performance requirements demonstrated by laboratory testing.

C. Shop-fabricate MCM systems and accessories by fabricator's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with requirements of MCM panel manufacturer, of indicated system profiles, and with dimensional and structural requirements.

1. Fabricate panels to dimensions indicated on Drawings based on an assumed design temperature of 70 deg F (21 deg C). Allow for ambient temperature range at time of fabrication.
2. Formed MCM panel lines, breaks, and angles to be sharp and straight, with surfaces free from warp or buckle.
3. Fabricate panels with sharply cut edges and no displacement of face sheet or protrusion of core.
4. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
5. Fabricated Panel Tolerances: Shop-fabricate panels to sizes and joint configurations indicated on Drawings.

    a. Width: Plus or minus 0.079 inch (2 mm) at 70 deg F (21 deg C).
    b. Length: Plus or minus 0.079 inch (2 mm) at 70 deg F (21 deg C).
    c. Squareness: Plus or minus 0.079 inch (2 mm) at 70 deg F (21 deg C).
    d. Panel Bow: 0.8 percent maximum of panel length or width.

6. Fabricate MCM panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
7. Attach routed-and-returned panel flanges to panel clips with manufacturer's standard fasteners.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to 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.
4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and 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 in writing by metal manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted 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 unacceptable. 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. Coil-Coated Metal Finish:

1. PVDF Fluoropolymer: AAMA 2605, two-coat metallic fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

D. Zinc Finish: As noted above.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, MCM system supports, and other conditions affecting performance of the 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 MCM system 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 MCM system manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and assemblies penetrating MCM system to verify actual locations of penetrations relative to seam locations of MCM panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MCM SYSTEM

A. General: Install MCM system in accordance with system manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor MCM system securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving MCM system.
2. Flash and seal MCM system at perimeter of all openings. Fasten with self-tapping screws.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as MCM system work proceeds.
6. Align bottoms of MCM panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
7. Provide weathertight escutcheons for all items penetrating system.
8. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by MCM system manufacturer.

9. Attach MCM panels to supports at locations, spacings, and with fasteners recommended by manufacturer to meet listed performance requirements.

B. Attachment Assembly, General: Install attachment assembly required to support MCM panels and to provide a complete weathertight wall system, including tracks, drainage channels, anchor channels, perimeter extrusions, and panel clips.

1. Install subframing, furring, and other panel support members and anchorages in accordance with ASTM C955.
2. Install support system at locations, at spacings, and with fasteners recommended by MCM system manufacturer to meet listed performance requirements.
3. Air Barrier: After installation of attachment assembly and prior to installing metal composite material wall panels and at no additional cost to owner, provide the following;

    a. In accordance with recommendations of air barrier manufacturer and as directed by air barrier installer, seal penetrations in air barrier created by screws used to secure wall panel system support structure as required to ensure air barrier warranty is not compromised.
    b. In accordance with recommendations of air barrier manufacturer and as directed by air barrier installer, seal holes or tears in air barrier created by installation of metal composite material wall panels as required to ensure air barrier warranty is not compromised.
    c. After repairs to air barrier system, retest air barrier system for air and water tightness in accordance with requirements in Specification Section where applicable air barrier is specified and submit field reports of all retesting demonstrating compliance with requirements specified in Specification Section where applicable air barrier is specified.
    d. Prior to proceeding with metal composite material wall panel installation:

        1) Repeat repair and testing process until testing results comply with requirements specified in Specification Section where applicable air barrier is specified as acceptable to Architect.
        2) Arrange for inspection of all repairs to air barrier by air barrier manufacturer and air barrier installer and obtain written acceptance of air barrier system with repairs.

C. DBVC MCM System: Install vertical tracks or drain channels and horizontal tracks or channels at locations, at spacings, and with fasteners recommended by system manufacturer.

1. Insert matching MCM spline into tracks at joint reveal locations.

D. Install panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.

E. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install accessory components required for a complete MCM system assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by MCM system manufacturer.

F. 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 are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install trim to fit substrates and to result in waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

G. Provide separation between zinc panels and aluminum.

3.3 INSTALLATION TOLERANCES

A. Shim and align MCM panels within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m), non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles. Locate shims on the surface of the girts where possible. If shims are required to be located on the surface of the AVB they must be solid shims to gasket the penetrations.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed MCM system installation, including accessories.

B. MCM system will be considered defective if it does not pass inspections.

C. Prepare inspection reports.

3.5 CLEANING

A. Remove temporary protective coverings and strippable films as MCM panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, clean finished surfaces as recommended by MCM panel manufacturer. Maintain in a clean condition during construction. Do not mark on protective film as this can stain zinc panels.

B. After installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

3.6 PROTECTION

A. Replace MCM panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.23

SECTION 074243 – WOOD VENEER LAMINATE WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Exterior high pressure laminate composite panels at soffits.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate work results of this Section with other work.

B. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, panel system Installer, panel system manufacturer's representative, and installers whose work interfaces with or affects panels.
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 panel system 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 details, penetrations, openings, and condition of other construction that affect panel system.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for system assembly during and after installation.
8. Review procedures for repair of panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, manufacturer’s installation instructions, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel, system, and accessory.

1. Initial selection color samples.

B. Shop Drawings: Submit project specific shop drawings prepared by, or under supervision of, Structural Design Engineer as specified in Quality Assurance article below and including

Structural Design Engineer's stamp or seal on all shop drawings including system attachments and anchors.

1. Include fabrication and installation layouts of panel system; project specific details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, accessories, and special details. Include details showing integration of panel system with air barrier system such as back-sealing of fastener penetrations.
2. Provide signed and sealed drawings, by a qualified design professional in Project jurisdiction, of panel system showing compliance with performance requirements and design criteria identified for this Project.

C. Samples:

1. Panels: Submit three 8.5 by 11 inches (22 by 28 cm) for each finish.
2. Accessories: 8 inch (20 cm) long section.
3. Assembly Samples: Assemble panel, 15 by 8 inches (38 by 20 cm) in size showing subframe and fasteners.

D. Delegated Design Submittals: For panel system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Soffit panels and attachments.
2. Soffit-mounted items including lighting fixtures.

B. Certificates:

1. Manufacturer Certificate: Intertek Code Compliance Research Report (CCRR) indicating compliance with IBC.

C. Installation instructions: Submit manufacturer instructions including surface preparation and installation procedures.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. Building Product Disclosure and Optimization: Environmental product declarations (EPD) and Health Product Declaration (HPD) documentation.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panels.

B. Warranty Documentation: For panels.

1.7 QUALITY ASSURANCE

A. Manufacturers: Certified for chain of custody by an FSC-accredited certification body.

B. Manufacturer Qualifications: Minimum 5 years' experience. Provide representation by manufacturer's field representative during construction and provide written acceptance of installer and fabricator.

C. Installer Qualifications: An entity specializing in installation of panel systems that employs installers and supervisors who are trained, licensed, certified and approved by manufacturer.

D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

E. Mockups: Construct mockup, demonstrating product interfaces, intersections, and terminations.

1. Approved mockups establish work results standard.
2. Approved mockups may remain as a part of the Work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Refer to manufacturer user manual.

1. Transport panels strapped down horizontally to avoid sliding; protect edges and corners.

B. Storage: Refer to manufacturer user manual.

1. Maintain in original protective package until use.
2. Store in a clean, dry, enclosed, and ventilated area.
    a. Temperature: 50 degrees F (10 degrees C), minimum, 80 degrees F (27 degrees C), maximum.
    b. Humidity: 30 percent, minimum, 70 percent, maximum.
3. Store horizontally on elevated platforms, with supports 24 inches (60 cm) apart, maximum.
4. Cover panels to match original packaged condition while not in use.

C. Handling: Lift and move panels evenly to avoid scratching the decorative surface.

1.9 FIELD CONDITIONS

A. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

1.10 WARRANTY

A. Manufacturer Warranty:

1. Warrant against product failure. Failures include, but are not limited to, the following:

a. Structural failures including cracking, fading, and deforming.
b. Deterioration of materials beyond normal weathering.

2. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 SOFFIT PANELS (SPP-1)

A. High Pressure Laminate Wood Veneer Soffit Panels: High density panels with natural wood veneers, fire-resistant thermoset phenolic resin core, and UV-resistant coating. Wood veneered solid phenolic panel system using open joint ventilated rain screen system with a subframe system designed to accommodate moisture, thermal and differential movement within the panel-frame system. Used with soffit suspension system at exterior canopy locations as indicated on Drawings.

1. Basis of Design Product: NATURCLAD-WF manufactured by PARKLEX PRODEMA.
2. Substitutions: Not permitted.
3. Thickness: 3/8 inch (10 mm).
4. Size: As indicated on Drawings.
5. Color: Rustik Matte.
6. Joint Width: As indicated on Drawings.
7. Installation Method: Concealed fastening.
8. Physical Properties:

a. Modulus of Elasticity: 1,500,000 psi minimum, ASTM D1037.
b. Flexural Strength: 9,000 psi minimum crossgrain, 15,000 psi minimum longgrain, ASTM D1037.
c. Freeze-Thaw Resistance: No change, ICC-ES AC92 Section 3.2.2
d. Water Resistance: No change, ASTM D2247.
e. Resistance to Weathering: No change after 2,000 hours, minimum, ASTM G155.
f. Salt Spray Resistance: No change after 300 hours, minimum, ASTM B117.

2.2 ACCESSORIES

A. Manufacturer standard components as required for complete installation.

B. Concealed Fastening with Hanging Hooks: Aluminum J channels, hanging rails, hanging hooks, clamping screws, levelling screws, fixing screws.

C. Acceptable manufacturer for metal panel framing system basis-of-design and quality;

1. PRODEMA proprietary corrosion-resistant aluminum framing and concealed fastening hanger attachment hardware.

D. Sealant: Silicone, color to match panel.

2.3 PERFORMANCE

A. Delegate support framing design to manufacturer licensed Professional Engineer.

B. Structural Design Criteria and Loads: See Structural Drawings.

C. PARKLEX PRODEMA products meeting ASTM E84.

D. Surface Burning Performance: ASTM E84 Class A.

1. Flame Spread Index: 25, maximum.
2. Smoke Developed Index: 450, maximum.

E. Environmental Performance:

1. Expansion and Contraction: Withstand 120 degree F (67 degree C) ambient and 180 degree F (100 degree C) surface thermal cycling without failure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Condition product per manufacturer recommendations.

3.3 INSTALLATION, GENERAL

A. Follow manufacturer instructions.

B. Anchor panels and sub-framing securely per engineering recommendations and approved Shop Drawings to allow for necessary movement and structural support.

C. Cut and drill panels, confirming fixed and floating points, and locate fastener hole spacing according to manufacturer recommendations.

D. Install plumb, level, and accurately spaced according to manufacturer recommendations and approved submittals and Shop Drawings.

E. Fasten panels with fasteners approved for use with supporting substrate.

F. Maintain 3/4 inch (20 mm) minimum air space behind panels.

G. Maintain base and head ventilation spaces of 3/4 inch (20 mm), minimum.

H. Fastener and hanging hooks to edge distance within manufacturer recommendation.

I. Replace damaged panels.

3.4 INSTALLATION, CONCEALED FASTENING SYSTEM

A. Install hanging rails over uninterrupted subframe components 3/4 inch (20 mm) deep minimum, spaced per manufacturer recommendations.

B. Install hooks on back of panels per manufacturer instructions.

C. Hang hooks on rails, adjust height for consistent joint spacing and lock panel in place horizontally with screw through top center hook.

D. Maintain gap between panels of 1/4 inch (6 mm), minimum.

E. Maintain distance from hanging hook to panel edge per manufacturer recommendations.

3.5 CLEANING

A. Follow manufacturer cleaning instructions.

B. Remove protection film immediately after installation.

C. Clean finished surfaces as recommended by panel manufacturer; do not use abrasive cleaners.

END OF SECTION 074243

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Walkways.
10. Safety stripping.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 077100 "Roof Specialties" for premanufactured copings and roof edge flashings.
5. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
6. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.

1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier 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. Review deck substrate requirements for conditions and finishes, 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.

B. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier 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.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Asphalt materials.
8. Electronic leak detection (ELD) materials.
9. Ballast.
10. Walkways.
11. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Product Data: For adhesives and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
4. Environmental Product Declaration: For each product.
5. Health Product Declaration: For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Project specific. Include roof plans, sections, manufacturer's installation instructions, project specific details, transitions to other systems that comprise the air and water control layers, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation thickness and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with air barrier.

D. Samples for Verification: For the following products:

1. Roof membrane and flashing, of color required.
2. Walkway pads or rolls, of color required.

E. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

    a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field Test Reports:

1. Concrete internal relative humidity test reports.

2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

H. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. Five years installation experience with specified roof system and specific manufacturer.

1.8 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.

1.9 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.

B. Safety requirements:

1. All applications, material handling, and associated equipment shall conform to and be operated in conformance with OSHA safety requirements.
2. Comply with federal, state, local and owner fire and safety requirements
3. Advise owner when any work is expected to be hazardous to owner or employees
4. Maintain a crewman as a floor area guard whenever roof decking is being repaired or replaced.
5. Maintain fire extinguisher within easy access whenever power tools and torches are being used.

C. Environmental requirements:

1. Do not work in rain, snow, or in presence of water.
2. Do not work in temperatures below 40 F without permission from architect and roof manufacturer
3. Do not install materials marked “keep from freezing” when daily temperatures are scheduled to below 40 F.
4. Remove any work damaged by freezing
5. Advise the Owner when volatile materials are to be used near air ventilation intakes so that they can be shut down or blocked as owner requires.

1.10 WARRANTY

A. Special Manufacturer’s 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 roof membrane, base flashings, roof insulation, adhesives, fasteners, cover boards, vapor retarders, substrate boards, copings, walkway products, fascias, cants, nailers, blocking, as well as all metal work and other components of roofing system.
2. Warranty Period: 20 years from date of Substantial Completion. No dollar limit.

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 roof membrane, base flashings, roof insulation, adhesives, fasteners, cover boards, substrate boards, vapor retarders, copings, walkway products, fascias, cants, nailers, blocking as well as any metal work, and other components of roofing system for the following warranty period:

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897. Refer to Structural Drawings for design criteria.

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: Class 1A-120.
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 SH.

E. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 or initial SRI not less than 82 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

F. Energy Performance: Roofing system to have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested in accordance with ANSI/CRRC S100.

G. Exterior Fire-Test Exposure: ASTM E108 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.

H. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 POLYVINYL CHLORIDE (PVC) ROOFING SYSTEM (PVC-1 & PVC-2)

A. PVC Sheet Type III, Fabric Backed: ASTM D4434/D4434M, fabric reinforced and fabric backed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Duro-Last Inc.; Duro-Fleece or a comparable product by one of the following:

a. Carlisle Syntec Systems.
b. Sika Corporation.
c. *Johns Manville: a Berkshire Hathaway company.*

2. Membrane Thickness: 80 mils (2.0 mm).
3. Exposed Face Color: PVC-1: White, PVC-2: Light Gray.

B. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

2.3 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants 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. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Bonding Adhesive: Manufacturer's standard.

E. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.

F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors an integral caulk ledge.

G. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

H. Miscellaneous Accessories: Provide manufacturer recommended preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Certainteed; SAINT-GOBAIN; GlasRoc Sheathing Type X.
b. Georgia-Pacific Gypsum LLC; Dens Deck Prime.
c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
d. USG Corporation; Securock Glass Mat Roof Board.

2. Thickness: Type X, 5/8 inch (16 mm).

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER

A. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

1. Basis-of-Design Product: Duro-Last Inc.; Vapor Barrier (DL VB).

2.6 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by PVC roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 3, felt or glass-fiber mat facer on both major surfaces.

1. Compressive Strength: 25 psi (172 kPa).
2. Size: 48 by 48 inches (1219 by 1219 mm).
3. Thickness:

a. Base Layer: 1-1/2 inches (38 mm).
b. Upper Layer: As indicated on Drawings.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch (6.35 mm).
3. Slope:

a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.
b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES AND COVER BOARD

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 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. As recommended by Manufacturer.
2. Verify adhesives and sealants 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. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Thickness: 1/2 inch (13 mm).

2.8 ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A. Conductive Medium: Materials providing less than 10^4 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.

1. Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer, UL listed and FM Global approved.
2. Grounding Screen: Welded, stainless steel mesh, for use with vector mapping system, FM Global approved.

B. Leak Detection and Moisture-Monitoring System (where indicated on Drawings): Permanent, embedded leak detection and moisture-monitoring system.

1. Sensors measuring moisture content, placed below roof insulation and connected to a monitoring program, with a notification indicating location of breach.

2.9 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

1. Color: As selected by Architect from manufacturer's full range of color selections.

2.10 SAFETY STRIPPING

A. Safety stripping: Safety Stripping composed of a laminated yellow PVC film on the top and a white PVC film on the bottom of a weft-inserted reinforcement fabric. The PVC film is a proprietary thermoplastic formulation that is resistant to ultraviolet rays, microorganisms, caustic chemicals, petroleum products, animal fats and acids. Install safety stripping to membrane per Manufacturer's written instructions using a hot-air welder. Refer to Drawings for location and extents.

1. Basis-of-Design Product: Duro-Last Safety Stripping.

PART 3 - EXECUTION

3.1 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 053100 "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.

    a. Test Frequency: One test probe per each 1000 sq. ft. (93 sq. m), or portion thereof, of roof deck, with no fewer than three test probes.
    b. Submit test reports within 24 hours of performing tests.

6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system 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.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 072726.04 "Fluid-Applied Membrane Air Barriers."

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches (610 mm) in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

    a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
5. 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.

3.5 INSTALLATION OF VAPOR RETARDER

A. 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 and 6 inches (90 and 150 mm), respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board and to marry with the roofing membrane if the materials are compatible.
2. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:

1. Install base layer of insulation with joints staggered not less than 24 inches (610 mm) in adjacent rows or end joints staggered not less than 12 inches (305 mm) in adjacent rows and with long joints continuous at right angle to flutes of decking. Stagger board joints in each direction.

    a. Locate end joints over crests of decking.
    b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).

        1) Trim insulation so that water flow is unrestricted.

    f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    h. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.

        1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
        2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.

    a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
    b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
    f. Trim insulation so that water flow is unrestricted.
    g. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    h. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm

Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

D. Installation Over Concrete Decks:

1. Install base layer of insulation with joints staggered not less than 24 inches (610 mm) in adjacent rows or end joints staggered not less than 12 inches (305 mm) in adjacent rows.

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
b. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
c. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).

1) Trim insulation so that water flow is unrestricted.

d. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
e. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
f. Adhere base layer of insulation to vapor retarder according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Prime surface of concrete deck with primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m), and allow primer to dry.
2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.

a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).

1) Trim insulation so that water flow is unrestricted.

f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
h. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 INSTALLATION OF COVER BOARDS

A. 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 (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

a. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

3.8 INSTALLATION OF ELD COMPONENTS

A. Install conductive medium over cover board and on vertical locations to receive roof membrane in accordance with manufacturer's written instructions.

B. Install sensors, wire loop, connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.9 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Start installation of roofing in presence of roofing system manufacturer's technical personnel Owner's testing and inspection agency.

D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

F. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.

G. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

H. Apply roof membrane with side laps shingled with slope of roof deck where possible.

I. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings 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 roof membrane and sheet flashings.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.10 INSTALLATION OF BASE FLASHING

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. Seal top of termination bar with sealant bead.

3.11 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.

1. Install flexible walkways at the following locations: As indicated on Drawings.
2. Provide 1-inch clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect. Perform welded seam testing regularly to evaluate the seam integrity such as at the beginning of each work day, after substantial pauses in installation activities, and if notable changes in weather occur.

B. Perform the following tests:

1. Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage horizontal membrane scanning platform membrane electric field vector mapping or vertical membrane scanning in accordance with ASTM D8231.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

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.

3.13 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 system 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.

3.14 ROOFING 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. Owner Address: <Insert address>.
3. Building Name/Type: <Insert information>.
4. Building 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 Roofing Installer will, at Roofing Installer's 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 (m/s)>;
    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 075419

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Custom flashing and trim fabrications, made from the following:

1. Sheet metal materials.
2. Underlayment.
3. Miscellaneous materials.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers and blocking.
2. Section 042000 "Unit Masonry" for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry.
3. Section 075419 "Polyvinyl-Chloride (PVC) Roofing" for materials and installation of sheet metal flashing and trim integral with roofing.
4. Section 074213.23 "Metal Composite Material Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
5. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, reglets, and counterflashings.
6. Section 077200 "Roof Accessories" for roof hatches and other manufactured roof accessory units.
7. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
8. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Project specific. For sheet metal flashing and trim.

1. Plans, elevations, sections, and attachment details.

2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.
12. Formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long by actual width.

D. Sustainable Design Submittals:

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Qualification Statements: For fabricator and installer.

D. Sample warranties.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Protect during delivery.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.8 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of flashings and trims 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 weathering.
c. Water leakage.

2. Warranty Period: Five years from date of Substantial Completion.

B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows 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 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
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

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to 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 are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. FM Approvals Listing: Manufacture and install roof edge flashings and copings that comply with requirements in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, Class 1A-120. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METAL MATERIALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: Coil-coated sheet, ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: 0.063 inch (1.60 mm).
2. Surface: Smooth, flat.
3. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

4. Exposed Coil-Coated Finish:

    a. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

5. Color: Custom colors. Match Architect's samples.
6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

C. Stainless Steel Sheet: ASTM A240/A240M, Type 316, dead soft, fully annealed.

1. Nominal Thickness: 0.0500 inch (1.270 mm).
2. Surface: Smooth, flat.
3. Exterior Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).

    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.

4. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F (111 deg C); and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (minus 29 deg C) or lower; ASTM D1970/D1970M.

C. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

C. Solder:

1. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

2. 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.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal and building expansion and contraction of exposed flashing and trim. Laps and splices are to be fabricated and installed in accordance with SMACNA provisions.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Stainless Steel.

B. Flashing Receivers: Fabricate from the following materials:

1. Stainless Steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than 4 inches (100 mm).
2. Lap end joints not less than 12 inches (300 mm).

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than 2 inches (50 mm).

D. Install slip sheet, wrinkle free, directly on substrate before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than 4 inches (100 mm).

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder or sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches (300 mm) o.c.
6. Space individual cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.
10. Set metal drip edge flashings in continuous bed of sealant compatible with AVB membrane. Metal flashing splice plates are to overlap with continuous lines of sealant.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 ft. (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pretin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder aluminum sheet.
3. Do not use torches for soldering.
4. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

5. Stainless Steel Soldering:

a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
b. Promptly remove acid-flux residue from metal after tinning and soldering.
c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless steel draw band and tighten.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches (100 mm) over base flashing.
3. Lap counterflashing joints minimum of 4 inches (100 mm).
4. Secure in waterproof manner by means of snap-in installation and sealant unless otherwise indicated.

3.5 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING

A. Clean and neutralize flux materials. Clean off excess solder.

B. Clean off excess sealants.

3.7 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in 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, as determined by Architect.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

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. Copings.
2. Roof-edge specialties.
3. *Roof-edge drainage systems.*
4. Counterflashings.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
3. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint cover assemblies.
4. Section 077200 "Roof Accessories" for roof hatches and other manufactured roof accessory units.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 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. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: For roof specialties.

1. Include project specific plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.
5. Include details of special conditions.
6. Include details for saddle flashings at roofing/coping terminations into adjacent walls.

D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

E. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include copings, roof-edge specialties, *roof-edge drainage systems* and counterflashings made from 12-inch (300-mm) lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of roof specialty.

C. Product Test Reports: For copings and roof-edge flashings, for tests performed by a qualified testing agency.

D. Sample Warranty: For manufacturer's special warranty.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified classand SPRI ES-1 tested to specified design pressure.

B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing-system warranty.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and set quality standards for fabrication and installation.

1. Build mockup of typical roof edge and saddle flashing condition as shown on Drawings.
2. Build mockup of typical roof edge, including copings, gutters and downspouts, approximately 10 feet (3.0 m) long, including supporting construction, seams, attachments, underlayment, and accessories. Mockup to include transitions of primary air and water control layers with the exterior wall construction.
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. 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. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 075419 "Polyvinyl-Chloride (PVC) Roofing."

B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
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

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. FM Approvals' Listing: Manufacture and install copings and roof-edge specialties that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-120. Identify materials with FM Approvals' markings.

D. SPRI Wind Design Standard: Manufacture and install copings and roof-edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COPINGS

A. Cantilevered Metal Copings (SMF-1): Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Metal-Era, Inc.; Perma-Tite Cantilever Coping or a comparable product by one of the following:

a. Elevate; Holcim Building Envelope; Elevate Cantilever Coping
b. Hickman; an MTL Company; PermaSnap Cantilever Coping.
c. PAC-CLAD; Petersen; a Carlisle company.

2. Formed Aluminum Sheet Coping Caps: Aluminum sheet, 18 ga. or thickness as required to meet performance requirements.

a. Surface: Smooth, flat finish.
b. Finish: Two-coat mica fluoropolymer.
c. Color: Custom color to match MP-2.

3. Corners: Factory mitered and mechanically clinched and sealed watertight.
4. Special Fabrications: As indicated on Drawings.
5. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.

a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

2.3 ROOF-EDGE SPECIALTIES

A. Roof-Edge Fascia (SMF-2, SMF-4, & SMF-6): Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous metal receiver with integral drip-edge cleat to engage fascia cover and secure single-ply roof membrane. Provide matching corner units.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hickman; an MTL Company; TerminEdge EX Fascia or a comparable product by one of the following:

a. Elevate; Holcim Building Envelope; Elevate AnchorGard SP Fascia.
b. Metal-Era, Inc.
c. PAC-CLAD; Petersen; a Carlisle company; PAC-TITE Angular Fascia FA.

2. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, 18 ga. or thickness as required to meet performance requirements.

a. Surface: Smooth, flat finish.
b. Finish: Two-coat mica fluoropolymer.
c. Color: Custom color to match MP-2 (@ SMF-1) & custom color to match MP-3 (@ SMF-6). Zinc finish to match MP-1 (@ SMF-4).

3. Corners: Factory mitered and mechanically clinched and sealed watertight.
4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
5. Receiver: Extruded aluminum, 0.080 inch (2.03 mm) thick.
6. Special Fabrications: As indicated on Drawings.

2.4 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Elevate; Holcim Building Envelope
2. Hickman; an MTL Company;
3. Metal-Era, Inc.
4. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.

B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Aluminum Sheet: 0.050 inch (1.27 mm) thick.
2. Gutter Profile: As indicated on Drawings.
3. Corners: Factory mitered and mechanically clinched and sealed watertight.
4. Gutter Supports: Gutter brackets with finish matching the gutters.

C. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Formed Aluminum: 0.050 inch (1.27 mm) thick.

2.5 COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ATAS International, Inc.
2. Berridge Manufacturing Company.
3. Fry Reglet Corporation.
4. Heckmann Building Products, Inc.
5. Keystone Flashing Company, Inc.
6. Metal-Era, Inc.

B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:

1. Stainless Steel: 0.0250 inch (0.635 mm) thick.

C. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

D. Stainless Steel Finish: ASTM A480/A480M No. 2B (bright, cold rolled, unpolished).

2.6 MATERIALS

A. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

2.7 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl adhesive,

with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F (116 deg C).
2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F (29 deg C).

2.8 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

B. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.9 FINISHES

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: Noticeable variations in same piece are unacceptable. 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.

D. Coil-Coated Aluminum Sheet Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Mica Fluoropolymer: AAMA 2605. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

1. Apply continuously under copings, roof-edge specialties and counterflashings.
2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials. Confirm compatibility of materials.

3.3 INSTALLATION, GENERAL

A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum and stainless steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal and building expansion and contraction of exposed roof specialties. Laps and splices are to be fabricated and installed in accordance with SMACNA provisions.

1. Space movement joints at a maximum of 10 feet with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 INSTALLATION OF COPINGS

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.5 INSTALLATION OF ROOF-EDGE SPECIALITIES

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.6 INSTALLATION OF ROOF-EDGE DRAINAGE-SYSTEM

A. Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches (610 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.

1. Provide elbows at base of downspouts at grade to direct water away from building.

3.7 INSTALLATION OF COUNTERFLASHINGS

A. Coordinate installation of counterflashings with installation of base flashings.

B. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.8 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 and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077129 - MANUFACTURED ROOF EXPANSION JOINTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flanged bellows-type roof expansion joints.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wooden curbs or cants for mounting roof expansion joints.
2. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-fabricated sheet metal expansion-joint systems, flashing, and other sheet metal items.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Flanged bellows-type roof expansion joints.

B. Shop Drawings: Project specific. For roof expansion joints.

1. Include plans, elevations, sections, and attachment details.
2. Include details of splices, intersections, transitions, fittings, method of field assembly, and location and size of each field splice.
3. Provide isometric drawings of intersections, terminations, changes in joint direction or planes, and transition to other expansion joint systems depicting how components interconnect with each other and adjacent construction to allow movement and achieve waterproof continuity.

C. Samples: For each exposed product and for each color specified, 6 inches (150 mm) in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each fire-barrier provided as part of a roof-expansion-joint assembly, for tests performed by a qualified testing agency.

C. Sample Warranties: For special warranties.

D. Field Quality-Control Reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer of roofing membrane.

1.6 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.

B. specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint seals, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Fire-Resistance Rating: Comply with ASTM E1966 or UL 2079; testing by a qualified testing agency to resist the spread of fire and to accommodate building thermal movements without impairing its ability to resist the passage of fire and hot gases. Identify products with appropriate markings of applicable testing agency.

1. Rating: Not less than fire-resistance rating of the roof assembly.
2. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 FLANGED BELLOWS-TYPE ROOF EXPANSION JOINTS

A. Flanged Bellows-Type Roof Expansion Joint (EXP JT-1 & EXP JT-3): Factory-fabricated, continuous, waterproof, joint cover with insulated vapor barrier consisting of exposed membrane bellows laminated to flexible, closed-cell support foam, and secured along each edge to 3- to 4-inch- (76- to 100-mm-) wide metal flange.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; BRJ-WC & BRJW-WC Series or a comparable product by one of the following:

a. Balco; a CSW Industrials Company.
b. Johns Manville; a Berkshire Hathaway company.

c. MM Systems Corporation.
d. Watson Bowman Acme Corp.
e. inpro Corporation.

2. Source Limitations: Obtain flanged bellows-type roof expansion joints approved by roofing manufacturer and that are part of roofing membrane warranty.
3. Joint Movement Capability: As indicated on Drawings.
4. Bellows: EPDM flexible membrane, nominal 60 mils (1.5 mm) thick.
5. Flanges: Stainless steel, 0.0188 inch (0.477 mm) thick.
6. Configuration: As indicated on Drawings.
7. Corner, Intersection, and Transition Units: Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints.
8. Cover Membrane: EPDM flexible membrane, factory laminated to bellows and covering entire joint assembly and curbs.

   a. Color: Black.

9. Accessories: Provide splicing units, adhesives, and other components as recommended by roof-expansion-joint manufacturer for complete installation.
10. Secondary Seal: Continuous, waterproof membrane within joint and attached to substrate on sides of joint below the primary bellows assembly.

    a. Drain-Tube Assemblies: Equip secondary seal with drain tubes and seals to direct collected moisture as indicated on Drawings.
    b. Thermal Insulation: Fill space above secondary seal with manufacturer's standard, factory-installed mineral-fiber insulation; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84.

11. Fire Barrier: Manufacturer's standard fire barrier for fire-resistance-rated expansion joint system.

B. Materials:

1. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
2. EPDM Membrane: ASTM D4637/D4637M, type standard with manufacturer for application.

2.3 MISCELLANEOUS MATERIALS

A. Adhesives: As recommended by roof-expansion-joint manufacturer.

1. Verify adhesives have a VOC content of 70 g/L or less.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.

1. Exposed Fasteners: Gasketed. Use screws with hex washer heads matching color of material being fastened.

C. Mineral-Fiber Blanket: ASTM C665.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joint openings, substrates, and expansion-control joint systems that interface with roof expansion joints, for suitable conditions where roof expansion joints will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions for handling and installing roof expansion joints.

1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.
2. Install roof expansion joints true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
3. Provide for linear thermal expansion of roof-expansion-joint materials.
4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
5. Provide uniform, neat seams.
6. Install roof expansion joints to fit substrates and to result in watertight performance.

B. Directional Changes: Install factory-fabricated units at directional changes to provide continuous, uninterrupted, and watertight joints.

C. Transitions to Other Expansion-Control Joint Assemblies: Coordinate installation of roof expansion joints with other exterior expansion-control joint assemblies specified in Section 079513.16 "Exterior Expansion Joint Cover Assemblies" to result in watertight performance. Install factory-fabricated units at transitions between roof expansion joints and exterior expansion-control joint systems.

D. Splices: Splice roof expansion joints to provide continuous, uninterrupted, and waterproof joints.

1. Install waterproof splices and prefabricated end dams to prevent leakage of secondary-seal membrane.

E. Fire Barrier: Install fire barrier as required by manufacturer to provide continuous, uninterrupted fire resistance throughout length of roof expansion joint, including transitions and end joints.

F. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Tests: Perform the following tests on representative areas roof expansion joints.

1. Field Water Penetration Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration.

    a. Perform a minimum of three tests in areas as directed by Architect.

2. Prepare test reports.

END OF SECTION 077129

SECTION 077200 - ROOF ACCESSORIES

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. *Roof curbs.*
2. Roof hatches.
3. Aluminum roof walkway system.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing and miscellaneous sheet metal trim and accessories.
3. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, and counterflashing.
4. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint covers.

1.3 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.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.

1. Include project specific plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work. Include manufacturer's installation instructions.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

D. Delegated-Design Submittal: For *roof curbs and* roof walkway system 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 mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

C. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original packaging. Store materials in a dry, protected, well-vented area. Inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof walkway system *and roof curbs* to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS (RF ACC-2)

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ATAS International, Inc.
b. Greenheck Fan Corporation.
c. Pate Company (The).
d. Roof Products, Inc.

B. Size: Custom size. Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Aluminum sheet, 0.125 inch (3.17 mm) thick.

1. Finish: Mill.

E. Construction:

1. Curb Profile: Profile as indicated on Drawings compatible with roofing system.
2. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
4. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
5. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.

6. *Liner: Same material as curb, of manufacturer's standard thickness and finish.*
7. *Nailer: Factory-installed wood nailer under top flange on side of curb, continuous around curb perimeter.*
8. *Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.*
9. *Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb. Delegated design for traffic-rated internal support structure.*
10. *Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.*

2.3 ROOF HATCHES (RH-1 & RH-2)

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Basis-of-Design Product: Subject to compliance with requirements, provide BILCO Company (The); TYPE SS-50TB Special Size, Single-Leaf, Thermally-Broken Aluminum Roof Hatch (RH-1) & TYPE D-50T Double-Leaf Aluminum Roof Hatch (RH-2) or a comparable product by one of the following:

    a. Activar Construction Products Group, Inc. - JL Industries.
    b. ACUDOR Products, Inc.
    c. Babcock-Davis.
    d. Milcor; a division of Hart & Cooley, Inc.
    e. O'Keeffe's Inc.
    f. Pate Company (The).

B. Type and Size: Single-leaf lid, 48 by ~~*96*~~*120* inches (RH-1) & Double-leaf lid, 60 by 60 inches (RH-2).

C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.

D. Hatch Material: Aluminum sheet.

1. Thickness: 11 ga.
2. Finish: Mill.

E. Construction:

1. Insulation: 3-inch- thick, polyisocyanurate board.
2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb. Integral cap flashing.
4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
5. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.

6. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware: Spring operators, hold-open arm, stainless steel spring latch with turn handles, stainless steel butt- or pintle-type hinge system, and padlock hasps inside and outside. Heavy-duty components.

1. Provide two-point latch on lids larger than 84 inches (2130 mm).
2. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.

G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

1. Height: 42 inches (1060 mm) above finished roof deck.
2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches (31 mm) in diameter or galvanized-steel tube, 1-5/8 inches (41 mm) in diameter.
3. Flat Bar: Galvanized steel, 2 inches (50 mm) high by 3/8 inch (9 mm) thick.
4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches (533 mm) in diameter.
5. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
6. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
7. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
8. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
9. Fabricate joints exposed to weather to be watertight.
10. Fasteners: Manufacturer's standard, finished to match railing system.
11. Finish: Manufacturer's standard.

a. Color: As selected by Architect from manufacturer's full range.

2.4 ALUMINUM ROOF WALKWAY SYSTEM (RF ACC-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide FixFast USA; KATT GW23 Walkway System or approved equal.

1. Walkway: 48” wide, mill finish, prefabricated high tensile expanded aluminum grating.

a. Working Load Limit; 1,000 pound industrial rated, suited for high frequency use.
b. Design and manufacture to meet applicable OSHA and ANSI regulations.
c. Provide structure to support walkway including, but not limited to, receiver track, support posts, toe boards, caps, bracing, and fasteners.
d. Provide rubber non-penetrating pads and aluminum outriggers as needed to accommodate roof slope.
e. Install in accordance with Manufacturers written instructions, recommendations and approved shop drawings. Provide protection board or membrane between baseplates and roof membrane (typical).
f. Refer to Drawings for location.

2.5 METAL MATERIALS

A. Aluminum Sheet: ASTM B209 (ASTM B209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.
2. Concealed Finish: Pretreat with 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 (0.013 mm).

B. Aluminum Extrusions and Tubes: ASTM B221 (ASTM B221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

C. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

D. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

E. Steel Tube: ASTM A500/A500M, round tube.

F. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

G. Steel Pipe: ASTM A53/A53M, galvanized.

2.6 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Underlayment:

1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D4397.
3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

D. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

F. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

H. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.7 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. *Roof Curb Installation: Install each roof curb so top surface is level.*

D. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.

E. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Clean exposed surfaces according to manufacturer's written instructions.

C. Clean off excess sealants.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 077253 - SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pad-type, flat-mounted metal snow guards.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Pad-type, flat-mounted metal snow guards.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

C. Samples:

1. Pad-Type Snow Guards: Full-size unit with installation hardware.

a. For units with factory-applied finishes, submit specified color.

D. Delegated Design Submittals: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 3.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

C. Structural Performance: Snow guards to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Drawings.

2.2 PAD-TYPE SNOW GUARDS (SG-1 & SG-2)

A. Pad-Type, Flat-Mounted Metal Snow Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Alpine SnowGuards.
b. Berger; division of OmniMax International, Inc.
c. IceBlox Inc.
d. Levi's Building Components.
e. Polar Blox, Inc.
f. Zaleski Snow-Guards for Roofs, Inc.

2. Material:

a. Aluminum Sheet: ASTM B209 (ASTM B209M), not less than 0.050 inch (1.27 mm) thick.

1) Finish: High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

a) Color: Custom color to match Architect’s sample..

b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, Class AZ50 (Class AZM150), Grade 40 (Grade 275), not less than 0.022 inch (0.56 mmthick.

1) Finish: High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

a) Color: Custom color to match Architect’s sample.

3. Attachment: Manufacturer's tested system, capable of resisting design loads.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as recommended by manufacturer.

B. Attachment for Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:

a. Adhere to metal roofing in accordance with manufacturer's written instructions.

END OF SECTION 077253

SECTION 077273 - VEGETATED ROOF SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tray-type vegetated roof assembly.
2. Walkway pavers.

B. Related Requirements:

1. Section 075419 "Polyvinyl-Chloride (PVC) Roofing" for roofing membrane, roof thermal insulation and roofing system warranty.
2. Refer to Section 329500 "Garden Roof Assembly" for tray-type vegetated roof assemblies and pregrown sedum mats and additional requirements.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each vegetated roof assembly.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include material descriptions for each growing medium.

B. Sustainable Design Submittals:

C. Irrigation: Provide manufacturer's cut sheets and calculations on irrigation systems indicating water usage rates and system efficiency.

1. Irrigation Submetering: Provide manufacturer cut sheets for irrigation metering equipment.

D. Native Planting, Action Submittals: Provide plant information indicating compliance with native and adapted planting requirements for rain gardens for rainwater management.

E. Vegetated Roof, Action Submittals: Provide manufacturer's cut sheets indicating compliance with vegetated roof requirements for rainwater management.

F. Shop Drawings: Project specific. For each vegetated roof assembly.

1. Include plans, sections, slopes, and drain locations.
2. Indicate dimensions, weights, and loads.

3. Detail field assembly of components, depth of growing media, and attachments to other work.
4. Indicate walkway pavers, coordination with lighting and accessories.

G. Samples for Verification: For each of the following components of vegetated roof assembly:

1. Preplanted Vegetative Mat: 12 by 12 inches (300 by 300 mm).
2. Growing Media: 1-pint (0.5-liter) volume of each growing medium, in sealed plastic bags labeled with content and source. Each Sample to be typical of the lots of growing media to be furnished. Provide an accurate representation of texture and composition.
3. Walkway paver, manufacturer's standard size, in each color and texture required; include installation accessories to illustrate assembly.
4. Access Boxes: One in each size and color required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of manufactured product.

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory, in accordance with methods established by the Association of Official Analytical Chemists, where applicable.

C. Product Test Reports: For complete analysis of each growing medium, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For vegetated roof assembly and plants, including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods.

B. Continuing Maintenance Proposal: From vegetated roof assembly Installer approved by roofing-membrane manufacturer to Owner, in the form of a standard two-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified vegetated roof assembly Installer, approved, authorized, or licensed by roofing-membrane manufacturer, whose work has resulted in successful establishment of vegetated roofs.

1. Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when vegetated roof assembly work is in progress.

1.7 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 on or near structures, utilities, walkways and pavements, or existing roof areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of debris-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with product certificates.

C. Handle and store materials, and place equipment in a manner to avoid overloading roof structure or damaging roofing membrane.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when optimum results may be obtained. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Refer to Section 329500 “Garden Roof Assembly”.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain vegetated roof assembly components, growing medium, plants accessories from single source from single manufacturer.

2.2 VEGETATED ROOF ASSEMBLIES

A. Refer to Section 329500 “Garden Roof Assembly”.

2.3 MANUFACTURED GROWING MEDIA

A. Refer to Section 329500 “Garden Roof Assembly”.

2.4 ACCESSORIES

A. Refer to Section 329500 “Garden Roof Assembly”.

B. Access Boxes: Manufacturer's standard stainless steel boxes with removable, rigid covers for accessing drains, valves, and switches beneath the finish elevation of growing medium; secure each cover with four noncorrosive screws.

1. Size: 12 inches (305 mm) in diameter by depth of vegetated roof assembly at each location.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine each area to receive vegetated roof assembly for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Verify that roof insulation over roofing membrane is in place, secure, and flush along all seams.
2. Verify that perimeter and other flashings are in place and secure along entire lengths where they will be covered by vegetated roof assembly.

B. Inspect growing medium.

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 growing medium within a planting area.
2. If growing medium is contaminated by foreign or deleterious material or liquid, remove growing medium and contamination and replace with new growing medium.

3.2 INSTALLATION, GENERAL

A. Protection Course: Cover roofing system with protection board with butted and fully taped joints before roofing system is subject to vegetated roof assembly installation work.

B. Install vegetated roof assembly in accordance with manufacturer's written instructions.

C. Access Boxes: Install access box at each drain, valve, and switch and at locations shown on Drawings. Install top of boxes 1 inch (25 mm) above the finish elevation of growing medium.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Perform the following tests:

1. Electronic Leak-Detection Testing:

a. Testing agency will test each deck area for leaks using an electronic leak-detection method that locates discontinuities in the roofing membrane.
b. Testing agency will perform tests on abutting or overlapping smaller areas as necessary to cover entire test area.

c. Testing agency will create a conductive electronic field over the area of roofing to be tested and electronically determine locations of discontinuities or leaks, if any, in the roofing.
d. Testing agency will provide survey report indicating locations of discontinuities if any.

2. Proceed with installation of vegetated roof assembly only after unsatisfactory conditions have been corrected.

C. Manufacturer's Field Service: Engage roofing-membrane manufacturer's authorized service representative to provide inspection of vegetated roof assembly installation and prepare inspection reports.

D. Correct deficiencies in work that do not comply with requirements.

E. Prepare test and inspection reports.

3.4 PROTECTION

A. Protect vegetated roof assemblies from damage, including growing-medium contamination, due to operations of other contractors and trades. Repair or replace damaged vegetated roof assemblies.

3.5 MAINTENANCE SERVICE

A. Maintenance Service: Provide maintenance by skilled employees of vegetated roof assembly Installer approved by roofing-membrane manufacturer. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than the specified maintenance period.

1. Assembly and Plant Maintenance: During maintenance period, maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing devices, resetting plants to proper elevations 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.

a. Replace growing medium that becomes displaced or eroded because of settling or other processes.
b. Apply treatments as required to keep plant materials, planted areas, and growing medium free of pests and pathogens or disease. Use integrated past 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.
c. Use only products and methods acceptable to roofing-membrane manufacturer.
d. Following maintenance period, instruct Owner and furnish written maintenance instructions as necessary for planting materials to develop and maintain healthy root structure.

2. Maintenance Period: 24 months from date of Planting Completion.

END OF SECTION 077273

SECTION 078100 - APPLIED FIRE PROTECTION

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. Sprayed fire-resistive materials.

B. Related Requirements:

1. Section 078123 "Intumescent Fire Protection" for mastic and intumescent fire-resistive coatings.

1.3 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.
2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Project specific. Framing plans or schedules, or both, indicating the following:

1. Extent of fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.

3. Minimum sprayed fire-resistive material thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of sprayed fire-resistive material after application.

D. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of sprayed fire-resistive material.

C. Evaluation Reports: For sprayed fire-resistive material, from ICC-ES.

D. Preconstruction Test Reports: For fire protection.

E. Field quality-control reports.

F. Manufacturer’s Certificates:

1. Certification from manufacturer, stating that proposed material is free of asbestos, including actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite and asbestos contaminated vermiculite.
2. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
3. Fireproofing Product Certificates: Provide certificates from fireproofing manufacturer, for each product required, indicating that;

    a. Steel to receive sprayed fireproofing should be unprimed; however, if it is primed, sprayed fireproofing manufacturer certify primers applied to steel in shop or field are compatible with sprayed-on fireproofing and will not impair its performance under fire exposure for applications indicated, as provided by ASTM E119 test. Include test and other data as evidence. Coordinate with structural steel Sections.
    b. Each fireproofing product complies with specified product requirements and is suitable for use indicated.
    c. Sprayed fireproofing has been completed in accordance with requirements to provide necessary fire resistance ratings. Provide Ratings Certificate.

4. Manufacturer Letter: Verifying that the UL Designs selected for the project are not load restricted.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by applied fire protection material manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution and for preconstruction testing.

1. Build mockup of each type of fire protection and different substrate and each required finish as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups of fire protection.

1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.

1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
2. Density: Test for density according to ASTM E605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with sprayed fire-resistive material.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain sprayed fire-resistive material manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 44 deg F (7 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fire protection for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: For field applications, verify coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

E. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

A. Sprayed Fire-Resistive Material: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.

1. Medium Density Spray-Applied Fire Resistive Material Products (FP-1): For concealed locations and in plenum ceilings and above suspended ceilings. Subject to compliance with requirements, provide one of the following:

a. Carboline Company; a subsidiary of RPM International; Southwest Type 7GP
b. GCP Applied Technologies, Inc.; Monokote Z-106/HY.
c. Isolatek International; Cafco 400.

2. High Density Spray-Applied Fire Resistive Material Products (FP-3): For exposed locations on columns, beams, and roof deck in mechanical and electrical rooms, penthouses, data rooms, elevator rooms and shafts, non-ducted air shafts, equipment rooms, and other service type rooms and where indicated on Drawings. Subject to compliance with requirements, provide one of the following:

a. Carboline Company; a subsidiary of RPM International; Pyrocrete 40.
b. GCP Applied Technologies, Inc.; Monokote Z146.
c. Isolatek International; Fendolite M-II.

3. Bond Strength: Minimum 430-lbf/sq. ft. (20.59-kPa) cohesive and adhesive strength based on field testing according to ASTM E736.
4. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E605.
5. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.375 inch (9 mm).
6. Combustion Characteristics: ASTM E136.
7. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 10 or less.
b. Smoke-Developed Index: 10 or less.

8. Corrosion Resistance: No evidence of corrosion according to ASTM E937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760.
11. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E859.
12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.
13. Finish: As selected by Architect from manufacturer's standard finishes

    a. Color: As selected by Architect from manufacturer's full range.

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.

A. Bonding Agent: Product approved by sprayed fire-resistive material manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

B. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.

C. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign

substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.

2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Verify that concrete work on steel deck is complete before beginning Work.

C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning Work.

D. Conduct tests according to sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Clean substrates of substances that could impair bond of fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection Work.

B. Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Metal Decks:

1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
2. Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.

F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.

G. Extend fire protection in full thickness over entire area of each substrate to be protected.

H. Install body of fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.

I. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

J. Cure fire protection according to sprayed fire-resistive material manufacturer's written instructions.

K. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

L. Finishes: Where indicated, apply fire protection to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC, Subsection 1705.13, "Sprayed Fire-Resistant Materials.", as indicated on Schedule of Special Inspections.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace fire protection that does not pass tests and inspections, and retest.
2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.

B. Repair fire protection damaged by other work before concealing it with other construction.

C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078100

SECTION 078123 - INTUMESCENT FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mastic and intumescent fire-resistive coatings.

B. Related Requirements:

1. Section 078100 "Applied Fire Protection" for sprayed fire-resistive materials (SFRM).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, design ratings, restrained and unrestrained conditions, thicknesses, and other performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Mastic and intumescent fire-resistive coatings.
2. Substrate primers.
3. Topcoat.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of fire protection for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum mastic and intumescent fire-resistive coating thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of mastic and intumescent fire-resistive coating after application.

D. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of mastic and intumescent fire-resistive coating.

C. Evaluation Reports: For mastic and intumescent fire-resistive coating, from ICC-ES.

D. Field quality-control reports.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by mastic and intumescent fire-resistive coating manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of each type of fire protection and different substrate and each required finish as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 50 deg F (10 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fire protection for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested in accordance with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: For field applications, verify coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.

E. Asbestos: Provide products containing no detectable asbestos.

2.2 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS (FP-2)

A. Mastic and Intumescent Fire-Resistive Coating: Manufacturer's standard, factory-mixed formulation, and complying with indicated fire-resistance design.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Isolatek International; CAFCO SprayFilm WB 5 or a comparable product by one of the following:

a. Albi Manufacturing; a division of StanChem, Inc.
b. Carboline Company; a subsidiary of RPM International.
c. Contego International, Inc.
d. Hilti, Inc.

2. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design.
3. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 50 or less.

4. Finish: Level 2, Smooth.

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with mastic and intumescent fire-resistive coating and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by mastic and intumescent fire-resistive coating manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Topcoat: Suitable for application over mastic and intumescent fire-resistive coating; of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Conduct tests in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Clean substrates of substances that could impair bond of fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by mastic and intumescent fire-resistive coating manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other materials and procedures affecting fire protection Work.

B. Comply with mastic and intumescent fire-resistive coating manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and mastic and intumescent fire-resistive coating manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

E. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

F. Extend fire protection in full thickness over entire area of each substrate to be protected.

G. Install body of fire protection in a single course unless otherwise recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

H. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

I. Cure fire protection in accordance with mastic and intumescent fire-resistive coating manufacturer's written instructions.

J. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC, Subsection 1705.14, "Mastic and Intumescent Fire-Resistant Coatings."

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace fire protection that does not pass tests and inspections, and retest.
2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect fire protection, in accordance with advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.

B. Repair fire protection damaged by other work before concealing it with other construction.

C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078123

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

C. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A third-party contractor which specializes in penetration firestopping and meets one of the following requirements:

1. FM Research approved in accordance with FM Standard 4991, or
2. UL Qualified Firestop Contractor, or
3. Meet all of the following requirements:

a. Installation personnel shall be trained by the approved firestop manufacturer.
b. The installation firm shall be experienced in installing 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
c. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified tested and listed system requirements.
d. Minimum of three (3) years of experience and shown to have successfully completed not less than five (5) comparable scale projects with available references.

B. Installer: Subject to compliance with requirements, shall be one of the following:

1. Firestop Solutions.
2. Life Safety Services.
3. Remedi8.
4. Strike Pro Tech.
5. Universal Firestop Services.
6. Other pre-approved Installer.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."
3) FM Approvals in its "Approval Guide."

2.3 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any. All firestopping shall be red in color. Firestopping shall not be used in non-fire-rated applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. RectorSeal Firestop; a CSW Industrials Company.
d. Specified Technologies, Inc.
e. Tremco Incorporated.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:

    a. Those within the cavity of a wall.
    b. Floor, tub, or shower drains within a concealed space.
    c. 4-inch (200-mm) or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

1. Verify sealant has a VOC content of 250 g/L or less.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.4 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure 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 intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.

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: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

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.

K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.

L. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.

M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.

O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.

Q. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch (13 mm) diameter.

S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.

T. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping 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

3.1 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 the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with 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 penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming 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.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
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 the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping 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 penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.
2. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
3. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for fire-resistive manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
4. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.

        1) UL in its online directory "Product iQ."
        2) Intertek Group in its "Directory of Building Products."

B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.3 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

B. Intumescent Gypsum Wall Framing Gaskets (Applied to Steel Tracks, Runners and Studs prior to Framing Installation): Provide products with fire, smoke, and acoustical ratings that allow movement up to 100 percent compression and/or extension in accordance with UL 2079 or ASTM E1966; have an L Rating less than 1 cfm/ft. (0.00115 cu. m/s x m) in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 in accordance with ASTM E90 or ASTM C919.

C. For aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least 2-1/2 by 5 inches (64 by 127 mm), provide perimeter fire-barrier system that does not require direct screw attachment to mullions and transoms to support and fasten curtain-wall insulation. System to be tested in accordance with ASTM E2307 for up to 2-hour fire resistance and with ASTM E1233 for wind cycling equivalent to 108 mph (174 km/h) wind for 500 cycles.

D. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. RectorSeal Firestop; a CSW Industrials Company.
d. Specified Technologies, Inc.
e. Tremco Incorporated.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

E. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E2307.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. RectorSeal Firestop; a CSW Industrials Company.
d. Specified Technologies, Inc.
e. Tremco Incorporated.

2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

F. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. RectorSeal Firestop; a CSW Industrials Company.
d. Specified Technologies, Inc.
e. Tremco Incorporated.

2. L-Rating: Not exceeding 5.0 cfm/ft. (0.00775 cu. m/s x m) of joint at both ambient and elevated temperatures.

G. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

1. Verify sealant has a VOC content of 250 g/L or less.

2.4 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately 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 elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping 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. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition occurs, such as the intersection of a gypsum wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

3.3 INSTALLATION

A. General: Install joint firestopping 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 elastomeric 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 elastomeric 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 elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. (4.57 m) from end of wall and at intervals not exceeding 30 ft. (9.14 m).

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping 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 joint firestopping 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 joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product Category XHBN or Category XHDG.

B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Building Products" under product category Expansion/Seismic Joints or Firestop Systems.

C. Floor-to-Floor, Joint Firestopping Systems:

1. UL-Classified Systems: FF-D 0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.
4. W-Rating: No leakage of water at completion of water leakage testing.

D. Wall-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: WW-D0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

E. Floor-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: FW-D0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

F. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:

1. UL-Classified Systems: HW-D0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

G. Bottom-of-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: BW-D0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

H. Perimeter Joint Firestopping Systems:

1. UL-Classified Perimeter Fire-Containment Systems: CW-D0000-0999.
2. Linear Opening Width: As indicated on Drawings.

END OF SECTION 078443

SECTION 079100 - PREFORMED JOINT SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preformed, foam joint seals.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Preformed, foam joint seals.

B. Shop Drawings: Project specific details including, but not limited to, the following: terminations, transitions to waterproofing and roofing expansion joints, AWB transitions, typical exterior wall expansion joints, etc.

C. Samples for Initial Selection: Manufacturer's color sheets, showing full range of available colors for each type of exposed preformed joint seal.

D. Samples for Verification: Actual samples of each type and color of exposed preformed joint seal.

1. Size: 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint seals.

E. Preformed Joint Seal Schedule: Include the following information:

1. Joint seal location and designation.
2. Joint width and movement capability.
3. Joint seal manufacturer and product name.
4. Joint seal color.

F. Sustainable Design Submittals:

1. Product Data: For adhesives and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each preformed joint seal, for tests performed by qualified testing agency.

B. Sample warranties.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects and to set quality standards for materials and execution. Include a joint splice.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace preformed joint seals that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish preformed joint seals to repair or replace those that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For preformed joint seals, obtain each color, type, and variety of joint seal from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PREFORMED, FOAM JOINT SEALS

A. Preformed, Foam Joint Seals (PFJS-1): Dual-sided, pick resistant, watertight, hardened flexible polyurethane sealing surfaces adhered to fire-retardant impregnated foam backing Factory produce them in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.

1. Basis-of-Design Product: Subject to compliance with requirements, provide EMSEAL Joint Systems, Ltd, a Sika Company; Emshield SecuritySeal SSW2 or a comparable product by one of the following:

    a. BASF Corp. - Watson Bowman Acme Corp.
    b. MM Systems Corporation.
    c. Nystrom.
    d. Pecora Corporation.

2. Design Criteria:

    a. Nominal Joint Width: As indicated on Drawings.
    b. Minimum Joint Width: As indicated on Drawings.
    c. Maximum Joint Width: As indicated on Drawings.
    d. Movement Capability: As indicated on Drawings.

3. Joint Seal Color: As selected by Architect from full range of industry colors.

2.3 MISCELLANEOUS MATERIALS

A. VOC Content: Verify sealants and sealant primers comply with the following:

1. Architectural sealants have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for porous substrates have a VOC content of 775 g/L or less.

B. Primer: Material recommended by preformed joint seal manufacturer for joint substrates indicated.

C. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to preformed joint seal manufacturer, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces, and formulated to promote best adhesion to joint substrates.

D. Masking Tape: Nonstaining, nonabsorbent material compatible with preformed joint seals and surfaces adjacent to joints.

E. Transitions and Terminations: Provide manufacturer standard items such as Universal 90’s and Roof to Wall Closures that ensure continuity of seal where expansion joints change plane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive preformed joint seals, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting preformed joint seal performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing preformed joint seals to comply with preformed joint seal manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of preformed joint seal, including dust, paints (except for permanent protective coatings tested and approved for seal adhesion and compatibility by seal 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 optimal bond with preformed joint seals. 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.

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 seals. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.

B. Joint Priming: Prime joint substrates where recommended by preformed joint seal manufacturer or as indicated by tests or prior experience. Apply primer to comply with joint seal manufacturer's written instructions. Confine primers to areas of joint seal bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of adhesive or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

A. General: Comply with preformed joint seal manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Installation of Preformed, Foam Joint Seals:

1. Install each length of seal immediately after removing protective wrapping.
2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Tests: Perform the following tests on representative areas preformed joint seals.

1. Field Water Penetration Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration.

a. Perform a minimum of three tests in areas as directed by Architect.

2. Prepare test reports.

3.5 PROTECTION

A. Protect preformed joint seals from damage resulting from construction operations or other causes so seals are without deterioration or damage at time of Substantial Completion.

B. Cut out, remove, and repair damaged or deteriorated seals so repaired areas are indistinguishable from original work.

END OF SECTION 079100

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstaining silicone joint sealants.
2. Urethane joint sealants.
3. Mildew-resistant joint sealants.
4. Latex joint sealants.

B. Related Requirements:

1. Section 079100 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.
2. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Discussion topics shall include;

a. Schedule.
b. Sequence.
c. Coordination of trades.
d. Substrate review and acceptance.
e. Protection
f. Shop drawings and submittals.
g. Interface condition and details.
h. Environmental constraints.
i. Mockups.
j. Testing requirements.
k. Field quality control efforts.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Joint sealants.
2. Joint-sealant backing materials.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

E. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

B. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

C. Sample warranties.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

A. 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. Perform adhesion testing in mockups.

1.8 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 Architect.
2. Conduct field tests for each kind of sealant and joint substrate. Perform preconstruction testing for staining on stone substrates.
3. Notify Architect 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.
5. Test Method: Test joint sealants in accordance with Method A or method B, Tail Procedure and Flap Procedure, in ASTM C1521.

    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.

6. 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, Contractor is responsible for retest until satisfactory adhesion is obtained.
7. 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.

1.9 FIELD 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 (5 deg C).
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.

1.10 WARRANTY

A. Special Installer's Warranty: 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: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five 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 stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from 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

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, 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: Verify sealants and sealant primers comply with the following:

1. Architectural sealants have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for porous substrates have a VOC content of 775 g/L or less.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer’s full range except at the following locations:

1. Metal wall panels, wood veneered composite panels, curtain wall, aluminum framed storefront, and stone: exposed sealant to be custom color to match Architect’s sample. Submit sample(s) for approval.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.; Silpruf NB.
b. Pecora Corporation; Pecora 864NST.
c. Sika Corporation; Sikasil WS-295.
d. The Dow Chemical Company; DOW CORNING 756 SMS BUILDING SEALANT.
e. Tremco Incorporated; Spectrem 3.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bostik; Arkema.
b. Master Builders Solutions.
c. Pecora Corporation.
d. Sherwin-Williams Company (The).
e. Sika Corporation.
f. Tremco Incorporated.

B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bostik; Arkema.
b. Master Builders Solutions.
c. Pecora Corporation.
d. Sherwin-Williams Company (The).
e. Sika Corporation.
f. Tremco Incorporated.

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
b. Pecora Corporation; Pecora 860.
c. The Dow Chemical Company; DOW CORNING 786 SILICONE SEALANT.
d. Tremco Incorporated; Tremsil 200.

2.6 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; AC-20.
b. Sherwin-Williams Company (The); 850A Siliconized Acrylic Latex Caulk.
c. Tremco Incorporated; Tremflex 834.

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

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.

2.8 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

3.1 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 performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.
    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.

3.3 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 C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type 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. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at locations indicated on Drawings in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

a. Extent of Testing: Test completed and cured sealant joints as follows:

1) Perform 10 tests for the first 1000 ft. (300 m) of joint length for each kind of sealant and joint substrate.
2) Perform one test for each 1000 ft. (300 m) of joint length thereafter or one test per each floor per elevation.

b. Test Method: Test joint sealants in accordance with Method A or Method B, Tail Procedure and Flap Procedure, in ASTM C1521.

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.

c. Inspect tested joints and report on the following:

1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) 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 complies with sealant manufacturer's field-adhesion hand-pull test criteria.

d. 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 material, sealant configuration, and sealant dimensions.
e. 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.

2. 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. Contractor is responsible for retesting of failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 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.

3.6 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, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE (SLNT)

A. Exterior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

   a. Construction joints in cast-in-place concrete.
   b. Control and expansion joints in unit masonry.
   c. Joints in dimension stone cladding.
   d. Joints between metal panels.
   e. Joints between different materials listed above.
   f. Perimeter joints between materials listed above and frames of doors, windows and louvers.
   g. Control and expansion joints in ceilings and other overhead surfaces.
   h. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors unless noted otherwise. Provide sanded sealant joints at stone.

B. Interior joints in horizontal traffic surfaces:

1. Joint Locations:

   a. Isolation joints in cast-in-place concrete slabs.
   b. Control and expansion joints in tile flooring.
   c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Interior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Tile control and expansion joints.
   c. Vertical joints on exposed surfaces of unit masonry, concrete walls and partitions.
   d. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors, including custom colors.

D. Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement:

1. Joint Locations:

   a. Control joints on exposed interior surfaces of exterior walls.

b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 079513.16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior expansion joint covers.

B. Related Requirements:

1. Section 077129 "Manufactured Roof Expansion Joints" for factory-fabricated roof expansion joint cover assemblies.
2. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

1. Exterior expansion joint covers.

B. Shop Drawings: Project specific. For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by 6 inches (150 mm) long in size.

D. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by a qualified testing agency.

1.4 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.

B. Expansion Joint Design Criteria:

1. Type of Movement: Thermal Wind sway.

a. Nominal Joint Width: As indicated on Drawings.
b. Minimum Joint Width: As indicated on Drawings.
c. Maximum Joint Width: As indicated on Drawings.

2.3 EXTERIOR EXPANSION JOINT COVERS

A. Exterior Elastomeric-Seal Joint Cover (EXP JT-2): Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Model SC Series or a comparable product by one of the following:

a. Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC.
b. Balco; a CSW Industrials Company.
c. MM Systems Corporation.

d. Watson Bowman Acme Corp.
e. inpro Corporation.

2. Application: Wall to wall.
3. Type: Accordion.
4. Installation: Recessed.
5. Fire-Resistance Rating: Not less than that indicated on Drawings.
6. Exposed Metal:

a. Aluminum: Manufacturer's standard.

7. Seal Material: Santoprene.

a. Color: Two (2) custom colors to match Architect’s samples.

8. Secondary Seal: Manufacturer’s standard extruded-elastomeric seal designed to prevent water and vapor infiltration.

2.4 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M), Alloy 6063-T5 for extrusions; ASTM B209 (ASTM B209M), Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

C. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

2.5 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.

1. Provide where indicated on Drawings.

B. Manufacturer's standard attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Install frames in continuous contact with adjacent surfaces.

    a. Shimming is not permitted.

5. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.

C. Elastomeric Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

G. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 077129 "Manufactured Roof Expansion Joints." Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Tests: Perform the following tests on representative areas of exterior expansion joints.

1. Field Water Penetration Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration.

a. Perform a minimum of three tests in areas as directed by Architect.

2. Prepare test reports.

3.6 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections.

END OF SECTION 079513.16

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
2. Section 134900 "Radiation Protection" for lead-lined, hollow-metal doors and frames.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation 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.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

C. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Project specific. 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 electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.
10. Project specific details for exterior hollow metal doors and frames showing continuity with AWB and cladding (typ).
11. Floor anchorage to be coordinated with threshold installation and detailed in shop drawings. At exterior doors with no elevation change from the interior to exterior, the threshold seal is the primary seal keeping uncontrolled bulk water from entering the building. Having a continuous seal from the threshold to the weather barriers is integral to a performing enclosure.

D. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
2. Fabrication: Prepare Samples approximately 12 by 12 inches (305 by 305 mm) 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.

E. Product Schedule: For hollow-metal doors and frames, 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.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly, fire-rated borrowed-lite assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

C. Field quality control reports.

D. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

C. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.

1. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:

a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.37, R-Value 2.7, including insulated door, thermal-break frame and threshold.

2. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:

a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ceco Door; AADG, Inc.; ASSA ABLOY.
2. Curries, AADG, Inc.; ASSA ABLOY Group.
3. MPI Group, LLC (The).
4. Steelcraft; Allegion plc.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
2. 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.
3. 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 (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.37 deg Btu/F x h x sq. ft. (2.16 W/K x sq. m) when tested in accordance with ASTM C518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches (44.5 mm).
c. Face: Uncoated steel sheet, 16 ga.
d. Edge Construction: Model 1, Full Flush. Fully welded flush faces, welded and ground smooth.

e. Core: Polyurethane.
f. Fire-Rated Core: Manufacturer's standard core for fire-rated and temperature-rise-rated doors.

2. Frames:

a. Materials: 16 ga. (1.5-mm-) thick steel sheet, except door leafs 4’-0” and wider shall be 14 ga. (1.9-mm-) thick sheet steel.
b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

3. Exposed Finish: Prime.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified. Provide closure at jambs and head of door frame in order to provide a substrate for perimeter sealant.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches (44.5 mm).
c. Face: Metallic-coated steel sheet, 16 ga, with minimum A40 (ZF120) coating.
d. Edge Construction: Model 1, Full Flush. Fill seams with filler and grind smooth before finishing.
e. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches (3.2 mm in 51 mm).
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: Polyurethane.
i. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, 14 ga, with minimum A60 (ZF180) coating.
b. Construction: Full profile welded.
c. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16” positive thermal break and integral vinyl weatherstripping.

3. Exposed Finish: Prime.

2.5 BORROWED LITES

A. Fabricate of uncoated steel sheet, minimum thickness of 16 ga.

B. Construction: Full profile welded.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.7 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

F. 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 hollow-metal frames of type indicated.

G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

H. Glazing: Comply with requirements in Section 088000 "Glazing."

I. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.8 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite 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 welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, 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.

4. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; including but not limited to, electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".

    a. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
    b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
    c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section "Door Hardware".
    d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
3. Provisions for Electrical Devices: Provide steel conduit, boxes and other necessary devices required for the installation of electrical hardware in doors and frames.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
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. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

E. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

F. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:

1. Hinges: Minimum 9 ga. (3.8 mm) thick by 1-1/2 inches (38 mm) wide by 6 inches (152 mm) longer than hinge, secured by not less than 6 spot welds.
2. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 12 ga (2.6 mm) thick.
3. All Other Surface-Mounted Hardware: Minimum 14 ga. (1.9 mm) thick.
4. Provide overlapping hinge reinforcing full height of door.

G. Electrical Raceways: Provide hollow metal doors to receive electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through-wire transfer hardware or wiring harness specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware". Wire nut connections are not acceptable.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 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. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11 or NAAMM-HMMA 840.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work. All hollow metal frames shall be slushed full of grout.

    a. Where frames are fabricated in sections, 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 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.

2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.

5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.4 REPAIR

A. 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.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 088000 "Glazing" for glass view panels in flush wood doors.
2. Section 134900 "Radiation Protection" for lead-lined flush wood doors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door trim for openings.
5. Factory-machining criteria.
6. Factory-finishing specifications.

B. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Regional Materials: Manufacture wood doors within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
5. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
6. Chain-of-Custody Qualification Data: For manufacturer and vendor.
7. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Project specific. Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
4. Dimensions and locations of blocking for hardware attachment.
5. Dimensions and locations of mortises and holes for hardware.
6. Clearances and undercuts.
7. Requirements for veneer matching.
8. Doors to be factory finished and application requirements.

D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), 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. Plastic laminate, 6 inches (150 mm) square, for each color, texture, and pattern selected.
3. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
4. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Special warranties.

B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.6 QUALITY ASSURANCE

A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 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 bottom rail with opening number used on Shop Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations:

1. 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 and relative humidity at levels designed for building occupants for the remainder of construction period.

1.9 WARRANTY

A. Special Warranty: 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. Delamination of veneer.
b. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.

2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.

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.

B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.3 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI's "Architectural Woodwork Standards."

B. Doors are to be manufactured and certified by the manufacturer that they meet AWS Quality Standards.

C. Regional Materials: Manufacture wood doors within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

D. Certified Wood: Certify wood doors as "FSC Pure" or "FSC Mixed Credit" in accordance with FSC STD-01-001 and FSC STD-40-004.

E. Adhesives: Use adhesives that meet 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."

F. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.

2.4 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Masonite Architectural.
    b. Oshkosh Door Company.
    c. VT Industries, Inc.

2. Performance Grade: ANSI/WDMA I.S. 1A Heavy Duty.
3. ANSI/WDMA I.S. 1A Grade: Premium.
4. Faces: Single-ply wood veneer not less than 1/50 inch (0.508 mm) thick. Veneer shall have uniform color within each face.

    a. Species: As indicated on Drawings.
    b. Cut: As indicated on Drawings.
    c. Match between Veneer Leaves: Slip match.
    d. Assembly of Veneer Leaves on Door Faces: Center-balance match.

e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
f. Room Match:

1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet (6 m) or more.
2) Provide door faces of compatible color and grain within each separate room or area of building.

5. Exposed Vertical Edges: Same species as faces.

a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
b. Fire-Rated Pairs of Doors:

1) 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.

c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

1) Screw-Holding Capability: 475 lbf (2110 N) in accordance with WDMA T.M. 10.

d. Provide wood doors that have been tested for positive pressure by recognized independent testing laboratory, according to the applicable code requirements. Provide Category A Positive Pressure doors with the intumescent required for compliance contained within the door and require no additional installation of intumescent strips.

6. Core for Non-Fire-Rated Doors:

a. ANSI A208.1, Grade LD-1 particleboard.

1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
2) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware."

7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.

8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Flush rectangular beads.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. 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 on Drawings. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

2.6 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.

1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
2. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

1. Locate hardware to comply with DHI-WDHS-3.
2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.

C. Openings: Factory cut and trim openings through doors.

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 Section 088000 "Glazing."

2.7 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Factory finish doors. Doors to be factory finished to meet or exceed WDMA I.S. 1-A-13 specifications for a TR-8 UV cured acrylated urethane finish system or AWS section 5 specifications for a UV curable polyester urethane finish system. Factory finish to be water based stain and UV curable polyester urethane finish system that complies with all applicable

Federal and State regulations for Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAP) emission limitations per the EPA Clean Air Act.

C. Transparent Finish:

1. ANSI/WDMA I.S. 1A Grade: Premium.
2. Staining: Match Architect's sample.
3. Sheen: Match Architect’s sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors and frames in accordance with NFPA 80.
2. Install smoke- and draft-control doors in accordance with NFPA 105.

C. Job-Fitted Doors:

1. Align and fit doors in frames with uniform clearances and bevels as indicated below.

a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.

2. Machine doors for hardware.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
4. Clearances:

a. Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors.
b. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
c. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
d. Comply with NFPA 80 for fire-rated doors.

5. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.

6. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 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.

END OF SECTION 081416

SECTION 083323 - OVERHEAD COILING DOORS

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. Insulated service doors.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.3 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: Project specific. 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, 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.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.6 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.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling-door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

B. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:

1. Design Wind Load: As indicated on Drawings.
2. Testing: According to ASTM E330/E330M.
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.

2.3 DOOR ASSEMBLY (CD-1)

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Overhead Door Corporation; Stormtite AP Model 627 or a comparable product by one of the following:

a. Cookson; a CornellCookson company; ESD30.
b. Cornell; a CornellCookson company; ESD30 Thermiser Max.
c. McKeon Rolling Steel Door Company, Inc.
d. Raynor Garage Doors.
e. Wayne-Dalton Corp.

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. Air Infiltration: Maximum rate of 1.0 cfm/sq. ft. (5.1 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E283 or DASMA 105.

D. STC Rating: 28.

E. Insulated Door Curtain R-Value: 10.9 deg F x h x sq. ft./Btu.

F. Insulated Door Assembly U-Factor: 0.09 Btu/deg F x h x sq. ft.

G. Door Curtain Material: Galvanized steel.

H. Door Curtain Slats: Flat profile slats of 2-5/8-inch (67-mm) center-to-center height.

I. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from hot-dip galvanized steel and finished to match door.

J. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

K. Hood: Match curtain material and finish.

1. Shape: As indicated on Drawings.
2. Mounting: Face of wall.

L. Locking Devices: Equip door with locking device assembly and chain lock keeper.

1. Locking Device Assembly: Cremone-type, both jamb sides locking bars, operable from inside with thumbturn, outside with cylinder.

M. Electric Door Operator:

1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
2. Operator Location: Wall.
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 ft. (2.44 m) or lower.
4. Motor Exposure: Interior.
5. Motor Electrical Characteristics:

    a. Horsepower: As indicated on Drawings.
    b. Voltage: As indicated on Drawings.

6. Emergency Manual Operation: Chain type.
7. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar ; self-monitoring type.

    a. Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

8. Control Station(s): Interior mounted.

N. Curtain Accessories: Equip door with weatherseals.

O. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Custom color matching Architect's sample.
2. Interior Curtain-Slat Facing: Finish as selected by Architect from manufacturer's full range.

2.4 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 A653/A653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm); 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 E84 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 (0.25 mm).

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.

2.5 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- (0.71-mm-) thick, hot-dip galvanized-steel sheet with G90 (Z275) zinc coating, complying with ASTM A653/A653M.
2. No wording or illustrations allowed on hood where exposed to view unless required by the building code.

2.6 LOCKING DEVICES

A. 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: As standard with manufacturer and keyed to building keying system.
2. Keys: Three for each cylinder.

B. Chain Lock Keeper: Suitable for padlock.

C. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.7 CURTAIN ACCESSORIES

A. 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- (3-mm-) 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- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene.

2.8 COUNTERBALANCE 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. (2.5 mm/m) 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.

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.

2.9 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. 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.
2. above or below shaft; if above shaft, headroom is required.

D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Minimum as indicated for each door assembly. 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. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. er'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 non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

1. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

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.

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 (111 N).

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.

2.10 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 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.

2.11 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel or 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

3.1 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.

3.2 INSTALLATION, GENERAL

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 the accessibility standard.

D. Power-Operated Doors: Install according to UL 325.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to Architect.

B. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

C. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 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.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of coiling-door Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.7 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 083323

SECTION 083343 - OVERHEAD COILING SMOKE CURTAINS

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. Smoke-protective curtain assemblies for elevator entrances.
2. Smoke- and fire-protective curtain assemblies for elevator entrances.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

A. Coordinate smoke curtain assemblies with power, signal, fire-alarm, and smoke-detection systems specified in Division 26 and Division 28.

B. Coordinate elevator smoke-protective curtain assemblies with elevator hoistway door frames specified in Division 14.

C. Coordinate smoke-protective curtain assemblies with ceilings for operational clearances and maintenance access requirements.

D. Coordinate smoke-protective curtain assemblies with walls for support requirements, rating continuity above ceilings, and recessed wall switches.

E. Coordinate requirements for metal supports required for smoke-protective curtain assemblies.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of smoke-protective curtain assembly and draft curtain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for smoke curtains.
2. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
3. Include ratings, operating components, electrical characteristics, control systems, and furnished specialties and accessories.

B. Shop Drawings: Project specific. For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and attachment details.
2. Include details of smoke curtain assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Detail fabrication and assembly of fire-protective curtain assemblies.
5. Show locations of controls, detectors, and other accessories.
6. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 6 inches (152 mm) in length.

D. Product Schedule: For smoke curtain assemblies. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer, testing agency, and factory-authorized service representative.

B. Evaluation Reports: For curtain assemblies, from ICC-ES or another qualified testing agency.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For smoke curtain assemblies to include in emergency, operation, and maintenance manuals.

B. Field quality-control reports for required testing.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: An entity experienced in manufacturing smoke-and-draft-control curtain assemblies that have been successfully installed in compliance with requirements of authorities having jurisdiction.

B. 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.

C. Smoke-Protective Curtain Assembly Inspector Qualifications: Inspector for field quality control inspections of smoke-protective curtain assemblies complying with NFPA 105.

1.9 FIELD CONDITIONS

A. Field Measurements: Field-verify and coordinate dimensions and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of curtain assemblies that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

A. Source Limitations: Obtain smoke-protective curtains from single source from single manufacturer.

1. Obtain operators and controls from smoke-protective curtain manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Smoke Protective Curtain Assemblies: Provide smoke-protective curtains that are listed and labeled with the letter "S" on the rating label by a qualified testing agency for smoke- and draft-control based on testing in accordance with UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of opening at 0.10 inch wg (24.9 Pa) for both ambient and elevated temperature tests.

B. Smoke- and Fire-Protective Curtain Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible in accordance with UL 10D.

1. Oversize Rated Curtain Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that curtain assemblies comply with standard construction requirements for tested and labeled fire-rated curtain assemblies, except for size.
2. Smoke Control: Provide smoke-protective curtains that are listed and labeled with the letter "S" on the rating label by a qualified testing agency for smoke- and draft-control based on testing in accordance with UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of opening at 0.10 inch wg (24.9 Pa) for both ambient and elevated temperature tests.

C. Curtain Fabric Fire-Test-Response Characteristics: Provide products that pass NFPA 701, as determined by testing of fabrics that were treated using treatment-application method intended for use for this Project by a testing and inspecting agency acceptable to authorities having jurisdiction.

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.

2.3 SMOKE-PROTECTIVE CURTAIN ASSEMBLIES FOR ELEVATOR ENTRANCES (SMKC-2)

A. Alarm-activated transparent-film smoke curtain assembly complying with ICC-ES AC77.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Smoke Guard, a CSW Industrials Company; Elevator Smoke Curtain: M400 or a comparable product by one of the following:

1. CornellCookson, LLC.
2. Fire Curtain Technologies.
3. Stoebich
4. U.S. Smoke & Fire.

C. Smoke Containment: Assemblies complying with UL 1784 for air leakage and requirements of ASME 17.1/CSA B44.

D. Transparent-Film Curtain: Manufacturer's standard transparent film with flame-spread and smoke-developed indexes of 25 and 450, respectively, when tested in accordance with ASTM E84.

E. Operation: Controlled descent automatically by fail-safe motor-driven deployment and motorized rewind.

F. Curtain Attachment: Curtain shall form a pressure-resisting seal by one of the following methods:

1. Magnetic Adhesion: With Type 430 ferritic stainless steel elevator door frames, use magnets for closure with door frame.
2. Auxiliary Rails: With magnetic closure of curtain with incompatible elevator door frame material, provide magnetic stainless steel cladding for door frame, formed from ASTM A240/A240M, Type 430 ferritic stainless steel.

    a. Finish: Match stainless steel elevator door frame.

G. Control System: Provide factory-assembled control unit as required for assembly specified.

1. Fail-safe device deploys on activation of local smoke detector and building fire alarm or testing key switch in compliance with UL 864.
2. Curtain Rewind Switch: Include switch to rewind screen into housing.
3. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended in writing by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
4. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Housing Type: Sheet metal housings containing support rollers and associated electronics.

1. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2.4 SMOKE- AND FIRE-PROTECTIVE CURTAIN ASSEMBLIES FOR ELEVATOR ENTRANCES (SMKC-1)

A. Alarm-activated flame-resistant fabric smoke curtain assembly complying with ICC-ES AC77.

B. Basis-of-Design Product: Subject to compliance with requirements, provide McKeon Door Company; FireFighter Series Model D200E or a comparable product by one of the following:

1. CornellCookson, LLC.
2. Fire Curtain Technologies.
3. Smoke Guard, Inc.
4. Stoebich
5. U.S. Smoke & Fire.

C. Smoke Containment: Assemblies complying with UL 1784 for air leakage and requirements of ASME 17.1/CSA B44.

D. Fire-Resistance Rating of Fabric: Comply with UL 10D; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Rating: As indicated on Drawings.

E. Operation: Motorized automatic operation with controlled descent.

F. Automatic-Closing Device: Equip each deployable curtain assembly with fail-safe, gravity-closing device or holder-release mechanism and governor unit complying with UL 864 and NFPA 105, and an easily tested and reset release mechanism. Automatic-closing device shall be designed for activation by the following:

1. Manufacturer's standard UL-labeled smoke detector and holder-release devices.
2. Manufacturer's standard UL-labeled heat detector and holder-release devices.
3. Building fire-detection, smoke-detection, and fire-alarm systems.

G. Hood/Head Box: Manufactured from galvanized steel in accordance with ASTM A653/A653M; rated at the same temperature as the curtain fabric.

H. Curtain: Manufacturer's standard multilayer glass-fiber fabric woven-coated on one or both sides with egress.

1. Fire Rating: UL-listed fabric tested in accordance with UL 10D and ASTM E119 for fire resistance.

I. Roller: Manufacturer's standard curtain roller assembly to contain motor.

J. Weighted Bottom Bar: Provide weighted bottom bar to ensure smooth operation and hold curtain taut.

K. Curtain Guides: As selected by Architect from manufacturer's available standard materials and finishes.

L. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.

1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
2. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate 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.

3.2 INSTALLATION

A. Smoke- and Fire-Protective Curtains: Install in accordance with manufacturer's written installation instructions, NFPA 80, and NFPA 105.

B. Smoke-Protective Curtains: Install smoke-protective curtain assemblies in accordance with manufacturer's written installation instructions and NFPA 105.

1. Install smoke-protective curtain assemblies for elevator entrances in accordance with ASME 17.1/CSA B44.

C. Power-Operated Curtains: Install in accordance with UL 864.

D. Install anchorage devices to securely fasten assembly to substrate and building framing without distortion or stress.

E. Securely brace components suspended from structure.

F. Fit and align assembly, including vertical guides, level and plumb, to provide smooth operation.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified opening protective assembly inspector to perform tests and inspections and to furnish reports to Architect.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test release mechanism, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed curtain. Reset closing mechanism after successful test.

2. Inspections: Inspect each smoke-protective curtain assembly in accordance with NFPA 105.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each smoke-protective curtain assembly indicating compliance with each item listed in NFPA 105.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling smoke curtains.

3.5 MAINTENANCE

A. Engage a manufacturer's authorized service representative to test, adjust, and maintain the smoke-protective assemblies once per year, as required by NFPA 105.

END OF SECTION 083343

SECTION 084213 - ALUMINUM-FRAMED ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed entrance door systems.

B. Related Requirements:

1. Section 084413 "Glazed Aluminum Curtain Walls".

1.2 ACTION SUBMITTALS

A. Product Data:

1. Aluminum-framed entrance door systems.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, most current version of the manufacturer’s installation instructions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories.

C. Shop Drawings: Project specific.

1. Plans, elevations, sections, full-size details, and attachments to other work.
2. Details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
3. Full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrance door systems, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

4. Connection to and continuity with adjacent thermal, weather, air, and vapor barriers and adjacent construction.
5. Point-to-point wiring diagrams showing the following:

    a. Power requirements for each electrically operated door hardware.
    b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

6. Signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Size: Manufacturers' standard size.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) 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. Entrance Door Hardware Schedule: Prepared by or under 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 Submittals: For aluminum-framed entrances and storefront systems, including analysis data signed and sealed by the qualified professional engineer licensed in the State of Kentucky responsible for their preparation.

H. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
4. Environmental Product Declaration: For each product.
5. Health Product Declaration: For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.3 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: For aluminum-framed entrance door systems, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance.

B. Product Test Reports: For aluminum-framed entrance door systems, for tests performed by a qualified testing agency. Test reports shall be project specific and performed within the past 2 years.

C. Field Quality-Control Reports: For aluminum-framed entrance door systems.

D. Qualification Statements:

1. For Installer and field testing agency.

E. Delegated Design Engineer Qualifications: For aluminum-framed entrance and storefront systems.

F. Sample Warranties: For aluminum-framed entrance door systems.

G. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For aluminum-framed entrance door systems.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fabricator of products.
2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

C. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.

D. 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.

E. Accessible Entrances: Comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.6 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of aluminum-framed entrance door systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: 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 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of aluminum-framed entrance door systems, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrance door systems.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrance door systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at 150 percent of positive and negative wind-load design pressures, entrance doors, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
2. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Entrance Doors: U-factor of not more than 0.52 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.

2. Air Leakage:

a. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. (5.08 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

3. Condensation Resistance Factor (CRF):

a. Entrance Doors: CRF of not less than 49 frame and 68 glass as determined in accordance with AAMA 1503.

F. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.

1. Outdoor-Indoor Transmission Class: Minimum 32.

G. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 ALUMINUM-FRAMED ENTRANCE DOOR SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Company, Inc.; Arconic Corporation; 350T Insulpour Thermal Entrance or a comparable product by one of the following:

1. EFCO Corporation.
2. Wausau Window and Wall Systems; Apogee Wausau Group, Inc.

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction: 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) 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: Medium stile; 3-1/2-inch (88.9-mm) nominal width.
3. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets.

    a. Provide nonremovable glazing stops on outside of door.

4. Split finish: Custom anodized finish to match Architect’s sample (exterior) and custom color high-performance organic finish to match Architect’s sample (interior).

C. Framing Members: Manufacturer's standard extruded aluminum, minimum 0.125 inch (3.2 mm) thick and reinforced as required to support imposed loads.

1. Nominal Size: As indicated on Drawings.
2. Exterior Framing Construction: Thermally broken.
3. Finish: Match door finish.

D. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

F. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

    a. Sheet and Plate: ASTM B209 (ASTM B209M).
    b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).
    c. Structural Profiles: ASTM B308/B308M.

2. Steel Reinforcement:

    a. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
    b. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.

c. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

3. Steel Reinforcement Primer: 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 in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.
4. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

G. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

1. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

2.4 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.

1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:

a. Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.
b. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.

C. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

1. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

D. Cylinders:

1. As specified in Section 087100 "Door Hardware."

E. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

F. Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

G. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

H. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (12.7 mm).

I. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Comply with Section 088000 "Glazing."

C. Glazing Sealants: Comply with Section 088000 "Glazing."

1. Verify sealant has a VOC content of 250 g/L or less.

2.6 ACCESSORIES

A. Automatic Door Operators: Section 087113 "Power Door Operators."

B. 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.

C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

F. Rigid PVC filler.

2.7 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. 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 and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At interior and exterior doors, provide compression weather stripping at fixed stops.

E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.8 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Custom color. Match Architect's sample.

B. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: Custom color. Match Architect's sample.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOOR SYSTEMS

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. 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 installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

K. Install entrance 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.

L. Install glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Refer to Section 084413 “Glazed Aluminum Curtain Walls”.

3.4 MAINTENANCE SERVICE

A. Entrance Door Hardware Maintenance:

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 12 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. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.5 ENTRANCE DOOR HARDWARE SETS

A. Refer to Section 087100 “Door Hardware”.

END OF SECTION 084213

SECTION 084229.23 - SLIDING AUTOMATIC ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Sliding automatic entrances.

B. Related Requirements:

1. Section 087113 "Power Door Operators" for automatic door operators furnished separately from doors and frames.

1.2 DEFINITIONS

A. AAADM: American Association of Automatic Door Manufacturers.

B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.

C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.

D. For automatic door terminology, refer to BHMA A156.10 for definitions of terms.

1.3 COORDINATION

A. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing automatic entrances.

B. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.

C. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies and access-control system.

D. System Integration: Integrate sliding automatic entrances with other systems as required for a complete working installation.

1. Provide electrical interface control capability for activation of sliding automatic entrances by security access system on doors with electric locking.
2. Provide electrical interface to deactivate door operators on activation of fire alarm system.
3. Provide electrical interface to allow for remote monitoring of automatic entrance door panel status.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: Sliding automatic entrances.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

D. Shop Drawings: Project specific. For sliding automatic entrances.

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. 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.
4. Indicate locations of activation and safety devices.
5. Include hardware schedule and indicate hardware types, functions, quantities, and locations.

E. Samples for Initial Selection: For units with factory-applied finishes.

1. Include Samples of hardware and accessories involving color or finish selection.

F. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

G. Delegated Design Submittals: For automatic entrances.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Product Certificates: For each type of automatic entrance. Include emergency-exit features of automatic entrances serving as a required means of egress.

C. Product Test Reports: For each type of automatic entrance, for tests performed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For automatic entrances, safety devices, and control systems to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer with Company Certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project and who employs a Certified Inspector.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

C. Certified Inspector Qualifications: Certified by AAADM.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of automatic entrances 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 operators, controls, and hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain sliding automatic entrances from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Power-Operated Door Standard: BHMA A156.10.

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. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design automatic entrances.

D. Structural Performance: Automatic entrances to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with ASCE/SEI 7.

1. Wind Loads: As indicated on Drawings.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

F. Operating Temperature Range: Automatic entrances to operate within minus 20 to plus 122 deg F (minus 29 to plus 50 deg C).

G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-Factor):

a. Entrance Doors: U-factor of not more than 0.64 Btu/sq. ft. x h x deg F (3.58 W/sq. m x K) as determined in accordance with NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Entrance Doors: SHGC of not more than 0.28 as determined in accordance with NFRC 200.

3. Air Leakage:

a. Power-Operated Sliding Doors: Air leakage of not more than 1.0 cfm/sq. ft. (5.1 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

4. Condensation Resistance:

a. Entrance Doors: CR of not less than 22.

H. Opening Force:

1. Power-Operated Doors: Not more than 50 lbf (222 N) required to manually set door in motion if power fails, and not more than 15 lbf (67 N) required to open door to minimum required width.
2. Breakaway Device for Power-Operated Doors: Not more than 50 lbf (222 N) required for a breakaway door or panel to open.

I. Entrapment-Prevention Force:

1. Power-Operated Sliding Doors: Not more than 30 lbf (133 N) required to prevent stopped door from closing.

2.3 SLIDING AUTOMATIC ENTRANCES (ASLD-1 & ASLD-2)

A. General: Provide manufacturer's standard automatic entrances, including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, controls, and accessories required for a complete installation.

B. Sliding, Power-Operated Automatic Entrances:

1. Basis-of-Design Product: Subject to compliance with requirements, provide STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.; Dura-Glide 3000 or a comparable product by one of the following:

   a. ASSA ABLOY Entrance Systems; ASSA ABLOY; SL500 EcoDoor.
   b. Horton Automatics; Overhead Door Corporation.
   c. dormakaba USA Inc.; ESA 300.

2. Configuration, Biparting-Sliding: Biparting-sliding doors with two sliding leaves and sidelites on each side.

   a. Traffic Pattern: Two way.
   b. Emergency Breakaway Capability: Sliding leaves and sidelites.
   c. Mounting: Between jambs.

3. Operator Features:

   a. Power opening and closing.
   b. Drive System: Belt.
   c. Adjustable opening and closing speeds.
   d. Adjustable hold-open time between zero and 30 seconds.
   e. Obstruction recycle.
   f. On-off/hold-open switch to control electric power to operator, key operated.

4. Sliding-Door Carrier Assemblies and Overhead Roller Tracks: Carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.

   a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.

5. Sliding-Door Threshold: Threshold members and bottom-guide-track system with stainless steel, ball-bearing-center roller wheels.

    a. Configuration, Threshold: Saddle-type threshold across door opening and surface-mounted guide-track system at sidelites.

6. Controls: Activation and safety devices in accordance with BHMA standards.

    a. Activation Device, Motion Sensor: Mounted on each side of door header to detect pedestrians in activating zone and to open door.
    b. Safety Device, Photoelectric Beams: Two photoelectric beams mounted in sidelite jambs on each side of door to detect pedestrians in presence zone and to prevent door from closing.
    c. Safety Device, Presence Sensor on Sides of Door Header and Photoelectric Beams: Presence sensor mounted on each side of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing.
    d. Opening-Width Control: Two-position switch that in the normal position allows sliding doors to travel to full opening width and in the alternate position reduces opening to a selected partial opening width.

7. Finish (ASLD-1): Split Finish: Finish exterior framing, door(s), and header to match adjacent curtain wall (CW-1). Finish interior framing, door(s), and header with high-performance organic finish (two-coat fluoropolymer) in custom color to match Architect's sample.

8. Finish (ASLD-2): Finish framing, door(s), and header with high-performance organic finish (two-coat fluoropolymer) in custom color to match Architect's sample.

2.4 ENTRANCE COMPONENTS

A. Framing Members: Extruded aluminum, minimum 0.125 inch (3.2 mm) thick and reinforced as required to support imposed loads.

    1. Nominal Size: As indicated on Drawings.
    2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch (1.6-mm) wall thickness.

B. Stile and Rail Doors: 1-3/4-inch- (45-mm-) thick, glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.

    1. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
    2. Stile Design: As indicated on Drawings.
    3. Rail Design: As indicated on Drawings.
    4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.

C. Sidelite(s): 1-3/4-inch- (45-mm-) deep sidelite(s) with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members matching door design.

    1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
    2. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.

D. Headers: Fabricated from minimum 0.125-inch- (3.2-mm-) thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

1. Mounting: Concealed, with one side of header flush with framing.
2. Capacity: Capable of supporting doors of up to 175 lb (79 kg) per leaf over spans of up to 14 feet (4.3 m) without intermediate supports.

a. Provide sag rods for spans exceeding 14 feet (4.3 m).

E. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.

F. Signage: As required by cited BHMA standard.

1. Application Process: Door manufacturer's standard process.
2. Provide sign materials with instructions for field application after glazing is installed.

2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extrusions: ASTM B221 (ASTM B221M).
2. Sheet: ASTM B209 (ASTM B209M).

B. Steel Reinforcement: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.

C. Glazing: As specified in Section 088000 "Glazing."

D. Sealants and Joint Fillers: As specified in Section 079200 "Joint Sealants."

E. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C1107/C1107M; of consistency suitable for application.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

G. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

H. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

I. Regional Materials: Manufacture products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

2.6 DOOR OPERATORS AND CONTROLS

A. General: Provide operators and controls, which include activation and safety devices, in accordance with BHMA standards, for condition of exposure, and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.

B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.

1. Door Operator Performance: Door operators to open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
2. Electromechanical Operators: Concealed, self-contained, overhead units powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; complying with UL 325; and with manual operation with power off.

C. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed by their plastic housings; adjustable to provide detection-field sizes and functions required by BHMA A156.10.

1. Provide capability for switching between bi- and unidirectional detection.
2. For one-way traffic, sensor on egress side to not be active when doors are fully closed.

D. Presence Sensors: Self-contained, active-infrared scanner units; adjustable to provide detection-field sizes and functions required by BHMA A156.10. Sensors remain active at all times.

E. Photoelectric Beams: Pulsed infrared, sender-receiver assembly for recessed mounting. Beams to not be active when doors are fully closed.

F. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.7 HARDWARE

A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.

B. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door to be as stipulated in "Performance Requirements" Article. Interrupt powered operation of door operator while in breakaway mode.

1. Include two adjustable detent devices mounted in each breakaway panel; one top mounted and one bottom mounted to control breakaway force.

a. Panel Closer: Factory-installed concealed hydraulic door closer.
b. Limit Arms: Limit swing to 90 degrees, spring loaded with adjustable friction damping.

C. Access-Control Locking: Electrically controlled device mounted in header that automatically locks sliding door in closed position, preventing door panels from sliding manually. Provide fail-safe operation if power fails.

1. Include concealed, vertical-rod, tamper-proof exit devices, complying with UL 305, with latching into threshold and overhead carrier assembly and released by flush mounted and concealed within horizontal muntin bar, prohibiting manual breakout of door(s) from exterior.
2. Means of Egress: Vertical rod exit device.
3. Include locking devices for sidelites to prevent manual breakout.

D. Uninterrupted Power Supply: UL 1778, fully integrated unit mounted within header.

1. Power Interruption: Supply power to operator, controls, activation device, and safety systems of sliding automatic door for up to 1.5 hours of normal operation.
2. Include low-battery shutdown feature to safely open or close door prior to complete battery discharge.
3. Include audible battery replacement alarm to indicate that battery will no longer accept a charge and replacement is required.

E. Weather Stripping: Replaceable components.

1. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

2.8 FABRICATION

A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.

1. Form aluminum shapes before finishing.
2. 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.
3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.

    a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
    b. Reinforce members as required to receive fastener threads.

4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.

1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.

3. Form profiles that are sharp, straight, and free of defects or deformations.
4. Provide components with concealed fasteners and anchor and connection devices.
5. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
6. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
7. Allow for thermal expansion of exterior units.

C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

D. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.

E. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, in accordance with NGA's "GANA Glazing Manual."

F. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.

1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors and breakaway sidelites.

G. Controls:

1. General: Factory install activation and safety devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.
2. Install photoelectric beams in vertical jambs of sidelites, with dimension above finished floor as follows:

a. Top Beam: 48 inches (1219 mm).
b. Bottom Beam: 24 inches (610 mm).

2.9 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. 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 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Custom color. Match Architect’s sample.

B. High-Performance Organic Finish, Two-Coat: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: Custom color to match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.

B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic entrance installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install automatic entrances in accordance with manufacturer's written instructions and cited BHMA A156.10 for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.

1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
2. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.

B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.

1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
4. Level recesses for recessed thresholds using nonshrink grout.

C. Door Operators: Connect door operators to electrical power distribution system.

D. Access-Control Devices: Connect access-control devices to access-control system, as specified in Section 281300 "Access Control Software and Database Management."

E. Controls: Install and adjust activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel. Connect control

wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Glazing: Install glazing as specified in Section 088000 "Glazing."

G. Sealants: Comply with requirements specified in Section 079200 "Joint Sealants" to provide weathertight installation.

1. Set thresholds, framing members and flashings in full sealant bed.
2. Seal perimeter of framing members with sealant.

H. Signage: Apply signage on both sides of each door and breakaway sidelite, as required by cited BHMA standard for direction of pedestrian travel.

I. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 FIELD QUALITY CONTROL

A. Certified Inspector: Engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test and inspect each automatic entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.

C. Automatic entrances will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.

1. Adjust exterior doors for tight closure.

B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

C. Occupancy Adjustments: When requested within 12 months of 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.

3.5 CLEANING

A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

1. Comply with requirements in Section 088000 "Glazing" for cleaning and maintaining glass.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service to include 12 months' full maintenance by skilled employees of automatic entrance Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation. Parts and supplies to be manufacturer's authorized replacement parts and supplies.

1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
2. Perform maintenance, including emergency callback service, during normal working hours.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION 084229.23

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glazed aluminum curtain wall systems:

    a. Conventionally glazed.
    b. Two-sided, structural-sealant-glazed.

B. Related Requirements:

1. Section 014339 "Mockups".
2. Section 019115 "Building Enclosure Commissioning."
3. *Section 019117 "Building Enclosure Functional Performance Testing."*
4. Section 072100 "Thermal Insulation" for insulation materials field installed with glazed aluminum curtain wall systems.
5. Section 078443 "Joint Firestopping" perimeter fire-containment systems field installed with glazed aluminum curtain walls.
6. Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
7. Section 084213 "Aluminum-Framed Entrances" for entrance systems installed with glazed aluminum curtain-wall systems.
8. Section 088000 "Glazing" for curtain wall glazing.
9. Section 089119 "Fixed Louvers" for louvers installed in glazed aluminum curtain wall systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Confirm participants with Construction Manager.

1. Discussion topics shall include;

    a. Schedule.
    b. Sequence.
    c. Coordination of trades.
    d. Substrate review and acceptance.
    e. Protection
    f. Shop drawings and submittals.
    g. Interface condition and details.
    h. Environmental constraints.
    i. Mockups.
    j. Testing requirements.
    k. Field quality control efforts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, most current version of the manufacturer's installation instructions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
4. Environmental Product Declaration (EPD): For each product.
5. Environmental Product Declaration: For each product.
6. Health Product Declaration: For each product.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: For glazed aluminum curtain walls, including sunshades. Include project specific plans, elevations, sections, full-size details, and attachments to other work. Prepared by or under the supervision of a qualified professional engineer licensed in the State of Kentucky detailing fabrication and assembly of glazed aluminum curtain-wall systems.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers and adjacent construction.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) 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.

G. Delegated-Design Submittal: For glazed aluminum curtain walls and sunshades, including analysis data signed and sealed by the qualified professional engineer licensed in the State of Kentucky responsible for their preparation.

H. Provide THERM: Two-Dimensional Building Heat-Transfer Modeling at *thermally-broken sunshade connections and at* interfaces with adjacent opaque walls, roofs or slabs. Frame temperatures shall be confirmed to be maintained above the dew point temperature during design conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer and field testing agency.
2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.

B. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

C. Product Test Reports: For glazed aluminum curtain walls, for tests indicated in “Performance Requirements” section and performed by a qualified testing agency. Test reports shall be project specific and performed within the past 2 years.

D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For special warranties.

H. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.

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.

D. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed curtain wall assemblies.

E. Accessible Entrances: Comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation. Mockups will also be used to evaluate system installation and integration with the surrounding materials/systems.

1. Build mockup of typical wall area. ~~*Size of mockup to be determined by Architect and Construction Manager.*~~ *Refer to Section 014339 "Integrated Exterior Mockups" for additional requirements. Refer to Drawing A489 for scope of on-site standalone mockup.*
2. Testing shall be performed on mockups in accordance with requirements ~~*in "Field Quality Control" Article.*~~ *in Section 019117 "Building Enclosure Functional Performance Testing".*
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. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall 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 created by wind and thermal and structural movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed in the State of Kentucky, as defined in Section 014000 "Quality Requirements," to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls 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. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans of greater than 13 feet 6 inches (4.1 m).
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.

3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.

E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).

G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).
2. Maximum Water Leakage: In accordance with AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.

H. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: H/500 with connections capable of not less than 1/2” between stories.

2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement and 1.5 times the design displacement.

I. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Base thermal movement on a minimum of temperature differential: 170 degrees to 4 ~~-25~~ with nominal at 74 ~~72~~ degrees and interior RH at 60 ~~30~~ percent.

2. Thermal Transmittance (U-factor):

   a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.38 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
   b. Approximate calculated U Value of Basis-of-Design: 0.32. Refer to exterior glass types for additional information.

3. Solar Heat Gain Coefficient (SHGC):

   a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.36 (South, East and West faces) and 0.48 (North face) as determined in accordance with NFRC 200.
   b. Approximate calculated SHGC of Basis-of-Design: 0.21. Refer to exterior glass types for additional information.

4. Air Leakage:

   a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa) when tested in accordance with ASTM E283.

5. Condensation Resistance: When tested to AAMA Specification 1503, the Condensation Resistance Factor (CRF) shall not be less than: CRF glass 1-inch Double Glazed HP = 76, CRF frame = 79.

   a. All openings (vision glazing, spandrel glazing, glazed in IMP, etc.) shall be condensation free at 4 ~~-25~~ degrees F at interior conditions of 74 ~~72~~ degrees F and 60% ~~30%~~ RH.

6. Maintain continuous air and vapor retarder throughout assembly located in a line even with inside line of glass and heel bead of glazing sealant.

J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

   a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
   b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

K. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

L. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls 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.

2.2 SOURCE LIMITATIONS

A. Obtain all components of curtain-wall system and storefront system, including framing spandrel panels, venting windows, entrances, sun control, and accessories, from single manufacturer.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS (CW-1 Unitized; Steel-reinforced, CW-2 Unitized)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Company, Inc.; Arconic Corporation; 2500 UT Unitwall System or a comparable product by one of the following:

1. EFCO Corporation; 8750XD Unitized Curtain Wall System.
2. Wausau Window and Wall Systems; Apogee Wausau Group, Inc.; 7250i-UW Unitized Curtain Wall System.
3. *Fabricator's proprietary systems will be considered if they are in compliance with requirements of this specification.*

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Ultra-thermally broken.
2. Glazing System: Retained mechanically with gaskets on two sides and structural sealant on two sides (horizontal and corners as indicated on Drawings).
3. Glazing Plane: Front.
4. Split finish: Custom anodized finish to match Architect's sample (exterior) and custom color high-performance organic finish to match Architect's sample (interior).
5. System: Unitized system.
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.
8. Double gasketed and pressure equalized internal chambers with integrated continuous gutters at each floor.
9. Both vertical and horizontal mullion profiles are two piece design to accommodate differential movement within profile section and not within glazing pocket. Complete with thermally separated snap on custom profile mullion caps.

10. Energy efficient thermal separation between exterior and interior elements to reduce thermal transmission.
11. Face dimension of profile: As indicated on Drawings.
12. Panel Size: As Indicated on Drawings.
13. Anchorage: Adjustable system at each floor slab to allow for 1-inch tolerance in all directions (lateral, vertical, and orthogonal), plus up to 10 degrees out of plumb (vertical).
14. Mullion covers as selected by architect from the curtain wall Manufacturers profiles.

    a. Provide Custom thin-profile mullion extension cover profiles as indicated on Drawings.
    b. Provide custom jamb extension cover profiles as indicated on the drawings.

15. Curtain Wall (CW-1) will require some modification/customization as required to accommodate sunshade attachment, structural support and thermally-broken connections.
16. At Curtain Wall (CW-1) locations field fabricated (stick-built) systems are acceptable in lieu of unitized systems as long as the mullion sightlines are consistent between adjacent unitized and field-fabricated (stick built) systems and performance requirements are met.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Venting Windows:

1. Manufacturer's standard units, complying with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, and as follows:

    a. Window Type: Casement.
    b. Minimum Performance Class: AW.
    c. Minimum Performance Grade: 90.
    d. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:

        1) Cam handle keyed locking system.
        2) Steel or bronze operating arms.

    e. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
    f. Glazing: Same as adjacent glazed aluminum curtain-wall glazing.
    g. Finish: Match adjacent glazed aluminum curtain-wall finish.

E. Entrance Door Systems: Comply with Section 084213 "Aluminum-Framed Entrances".

2.4 SUN CONTROL (SCD-1)

A. Sunshades: Assemblies consisting of manufacturer's outrigger brackets and aluminum sunshade blades, designed for attachment to curtain wall with mechanical fasteners.

1. Orientation: As indicated on Drawings.
2. Projection from Wall: As indicated on Drawings.
3. Outriggers: As indicated on Drawings. Cantilevered aluminum plate outriggers to be delegated design by curtain wall manufacturer. Provide concealed aluminum splines and fasteners. *Provide thermally-broken connections.*

4. Finish: Custom color. Match Architect's sample.
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: ASTM C509 or ASTM C864. Comply with Section 088000 "Glazing.".

C. Flashing and sealant for perimeter of curtain wall:

1. Basis-of-Design Product: Tremco Proglaze ETA; 6-inch wide Extruded Silicone Rubber gasket with preformed corners; installed to curtain wall using extruded aluminum curtain wall glazing raceway or Tremco TR 15265 extruded aluminum adaptor, mechanically attached at 6-inch centers with Tremco 440 taped seal.
2. Gasket extends from curtain wall framing covering gap and sealing to moisture barrier using Tremco Spectrum 1 Silicone sealant. (Perform adhesion compatibility test prior to selection of sealant.)
3. *Color: As selected by Architect from Manufacturer's full range.*

D. Glazing Sealants: As recommended by manufacturer. Comply with Section 088000 "Glazing."

1. Verify sealant has a VOC content of 250 g/L or less.

E. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.

1. Color: Black.

F. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.

1. Color: Match structural sealant.

2.6 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.

3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: 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 in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

F. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

G. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

H. Regional Materials: Manufacture products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

2.7 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.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.8 FABRICATION

A. Curtain Wall Fabricators.

1. Approved Fabricators:

a. Advanced Glazing Contractors, Inc.
b. Pioneer Cladding & Glazing Systems, Inc.
c. Glass Solutions, Inc.

2. Other Fabricators will be considered. Fabricators shall have a minimum of seven (7) years' experience in the design, engineering, fabrication, and installation of curtain walls

of similar scale and complexity as this project and is subject to final approval by the Owner and the Architect.

B. Form or extrude aluminum shapes before finishing.

C. 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.

D. 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 and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
6. Components curved to indicated radii.

E. Fabricate components to resist water penetration as follows:

1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

F. Factory-Assembled Frame Units:

1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact with structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
3. Seal joints watertight unless otherwise indicated.
4. Install glazing to comply with requirements in Section 088000 "Glazing."
5. Install structural glazing.

    a. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
    b. Set glazing with proper orientation so that coatings face exterior or interior as specified.
    c. Apply structural silicone sealant to completely fill cavity, in accordance with sealant manufacturers written instructions with the framing and glazing in a fully supported position.
    d. Brace or stiffen framing and glazing in such a manner to prevent undue stresses on the glass edge seal and structural joints or movement of the glazing, until sealant is fully cured in accordance with manufacturer's recommendations.
    e. After structural sealant has completely cured, insert backer rod between lites of glass as recommended by sealant manufacturer.
    f. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.
    g. Clean and protect glass as indicated in Section 088000 "Glazing."

h. Retain bracing or stiffening until erected to prevent racking of units during transportation and erection.

G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.9 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Custom color. Match Architect's sample.

B. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Color and Gloss: Custom color. Match Architect's sample.

2.10 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated. Overlap splice plates with continuous lines of sealant.

H. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Curtain wall assemblies are to be protected during post-construction cleaning.

I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF OPERABLE UNITS

A. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

3.4 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.5 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing in accordance with sealant manufacturer's and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation, so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer's and framing manufacturer's written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure in accordance with manufacturer's recommendations.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.6 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.7 ERECTION TOLERANCES

A. Install glazed aluminum curtain walls to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:
    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
    c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Refer to Section 019117 “Building Enclosure Functional Performance Testing” for mockup tests and field tests.

~~*C. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.*~~

~~*D. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.*~~

~~*1. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.*~~

~~*a. Perform a minimum of three tests in areas as directed by Architect.*~~
~~*b. Perform tests in each test area as directed by Architect. Perform at least three tests each, prior to 10, 35, and 70 percent completion. Any uncontrolled water infiltration into the interior of the system that is not drained to the exterior is considered a failure.*~~

~~*2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).*~~

~~*a. Perform a minimum of three tests in areas as directed by Architect.*~~
~~*b. Perform tests in each test area as directed by Architect. Perform at least three tests each, prior to 10, 35, and 70 percent completion.*~~

~~*3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 10 lbf/sq. ft. (480 Pa), and shall not evidence water penetration. Any uncontrolled water infiltration into the interior of the system that is not drained to the exterior is considered a failure.*~~

E. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of six areas on each building facade.
2. Repair installation areas damaged by testing.

~~*F. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.*~~

~~*G. Aluminum-framed curtain walls will be considered defective if they do not pass tests and inspections. If they do not pass tests and inspections, Contractor shall make any necessary corrections and re-test until it passes.*~~

~~*H. Prepare test and inspection reports.*~~

3.9 CLEANING AND PROTECTION

A. Cleaning: Contractor shall clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance, and remove construction debris from project site. Legally dispose of debris.

B. Protection: Contractor shall protect the installed product's finish surfaces from damage during construction.

END OF SECTION 084413

SECTION 087100 - DOOR HARDWARE – CORE AND SHELL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Flush Wood Doors”.
3. Division 08 Section “Aluminum-Framed Entrances”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, 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. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of 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.
    h. Warranty information for each product.

4. 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.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.
    c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format.

Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified 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. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.

3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. 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. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.

d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

a. Hager Companies (HA) - BB Series, 5-knuckle.
b. Ives (IV) - 5BB Series, 5-knuckle.
c. McKinney (MK) - TA/T4A Series, 5-knuckle.

2.3 CONTINUOUS HINGES

A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:.

a. Hager Companies (HA).
b. Pemko (PE).
c. Select Hinges (SL).

B. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Hager Companies (HA).
b. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
c. Pemko (PE).

2.4 POWER TRANSFER DEVICES

A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets with a 1-year warranty. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

    a. Hager Companies (HA) - ETW-QC (# wires) Option.
    b. Ives (IV) - Connect.
    c. McKinney (MK) - QC (# wires) Option.

B. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

    a. Pemko (PE) - EL-CEPT Series.
    b. Securitron (SU) - EL-CEPT Series.
    c. Von Duprin (VD) - EPT-10 Series.

C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

    a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
    b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

    a. Hager Companies (HA) - Quick Connect.
    b. McKinney (MK) - QC-C Series.
    c. Von Duprin (VD) - Connect.

2.5 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Rockwood (RO).
    c. Trimco (TC).

B. Coordinators: ANSI/BHMA A156.3 door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Rockwood (RO).
    c. Trimco (TC).

C. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Pulls, where applicable, shall be provided with a 10” clearance from the finished floor on the push side to accommodate wheelchair accessibility.
5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
6. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Hiawatha, Inc. (HI).
    c. Rockwood (RO).

2.6 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers:

    a. Match Existing BEST Key System, Verify with Owner.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Restricted Keyway.

C. Small Format Interchangeable BEST Cores: Provide small format interchangeable cores (SFIC) by Allowance, core insert, removable by use of a special key; usable with other manufacturers' cylinders.

D. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

E. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).
4. Construction Control Keys (where required): Two (2).
5. Permanent Control Keys (where required): Two (2).

F. Construction Keying: Provide construction master keyed cylinders.

G. Construction Keying: Provide temporary keyed construction cores.

H. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.7 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).
b. MMF Industries (MM).
c. Telkee (TK).

P. Electronic Key Management System: Provide an electronic key control system with Stand-alone Plug and Play features including advanced RFID technology. Touchscreen interface with PIN access for keys individually locked in place. Minimum 1,000 system users and 21 iFobs for locking receptors. System shall have a minimum 250,000 audit events screen displayed or ability to be exported via USB port.

1. Manufacturers:

a. Medeco (MC).

2.8 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide locksets with functions and features as follows:

a. Heavy duty 12-gauge wrought steel case.
b. Stainless steel 3/4" one-piece anti-friction reversible latchbolt with a one-piece hardened stainless steel 1” projection deadbolt.
c. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
d. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
e. Meets UL Certification Directory ZHLL.R21744 for products used in windstorm rated assemblies.
f. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 16 million cycles or greater.
g. Status indicators inside, outside, or on both sides of doors as specified; available with wording for “locked/unlocked”, “vacant/occupied” or custom wording options. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status.
h. Ten-year limited warranty for mechanical functions.

2. Electromechanical locksets shall have the following functions and features:

a. Universal Molex plug-in connectors that have standardized color-coded wiring and are available in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
c. Options to be available for request-to-exit or enter signaling, latchbolt and deadbolt monitoring.
d. Optional high security monitoring with internal end-of-line monitoring alongside deadbolt privacy and integrated door position monitoring.
e. Two-year limited warranty on electrified functions.

3. Manufacturers:

a. Corbin Russwin Hardware (RU) - ML2000 Series.
b. Sargent Manufacturing (SA) - 8200 Series.
c. Schlage (SC) - L9000 Series.
d. Dormakaba Best (BE) – 45H Series

2.9 DEADLOCKS AND LATCHES

A. Narrow Case Deadlocks and Deadlatches: ANSI/BHMA 156.13 Series 1000 Grade 1 narrow case deadlocks and deadlatches for swinging or sliding door applications. All functions shall be manufactured in a single sized case formed from 12 gauge minimum, corrosion resistant steel (option for fully stainless steel case and components). Provide minimum 2 7/8" throw laminated stainless steel bolt. Bottom rail deadlocks to have 3/8” diameter bolts.

1. Manufacturers:

    a. Adams Rite Manufacturing (AD) - MS1850S / MS1950 Series.

2.10 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.11 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide exit devices with functions and features as follows:

    a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
    b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
    c. No catch points: addition of applied deflectors or other added components are not allowed.
    d. No visible plastic.
    e. Heavy duty end caps with flush and overlapping options made of stainless steel, brass, or bronze with architectural finishes.
    f. Constructed of all stainless steel.
    g. Stainless steel pullman type latch with deadlock feature.
    h. Narrow or wide style exterior trim as specified in the hardware sets.
    i. Center case adjustability on concealed vertical rod exit devices; single operation with hex key individually adjusts top or bottom latches. No retainer screws or clips required to maintain adjustment.
    j. Ten-year limited warranty for mechanical features.

2. Electromechanical exit devices shall have the following functions and features:

    a. Universal Molex plug-in connectors that have standardized color-coded wiring and are field configurable in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
    b. Wire routing for all non-access control electromechanical functions and EcoFlex trim to be contained within the carrier of the device eliminating the need for cavities in doors to be drilled. Include a protective film so that wires don't get damaged if the rail needs to be removed.
    c. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
    d. Options to be available for request-to-exit or enter signaling, latchbolt and touchbar monitoring.

e. Field configurable electrified trim to fail-safe or fail-secure that operates from 12-24VDC.

3. Manufacturers:

a. Corbin Russwin Hardware (RU) - PED4000 / PED5000 Series.
b. Sargent Manufacturing (SA) - PE80 Series.
c. Von Duprin (VD) - 35A/98 XP Series.

2.12 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Heavy duty surface mounted door closers shall have a 30-year warranty.

2. Manufacturers:

a. LCN Closers (LC) - 4040 Series.
b. Norton Rixson (NO) - 7500 Series.
c. Sargent Manufacturing (SA) - 351 Series.

2.13 SURFACE MOUNTED CLOSER HOLDERS

A. Electromagnetic Door Holders: ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate.12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.

1. Manufacturers:

    a. LCN Door Closers (LC) - SEM7800 Series.
    b. Norton Rixson (RF) - 980/990 Series.
    c. Sargent Manufacturing (SA) - 1560 Series.

2.14 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

    a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Hiawatha, Inc. (HI).
    c. Rockwood (RO).

2.15 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Hiawatha, Inc. (HI).
    c. Rockwood (RO).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and

shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

    a. Norton Rixson (RF).
    b. Rockwood (RO).
    c. Sargent Manufacturing (SA).

2.16 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

    1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: 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 UL-10C.

    1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

    1. National Guard Products (NG).
    2. Pemko (PE).
    3. Reese Enterprises, Inc. (RE).

2.17 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

    1. Manufacturers:

a. Sargent Manufacturing (SA) - 3280 Series.
b. Security Door Controls (SD) - DPS Series.
c. Securitron (SU) - DPS Series.

B. Switching Power Supplies: Provide power supplies with either single or dual voltage configurations at 12 or 24VDC. Power supplies shall have battery backup function with an integrated battery charging circuit and shall provide capability for power distribution, direct lock control and Fire Alarm Interface (FAI) through add on modules. Power supplies shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs.

1. Manufacturers:

a. Securitron (SU) - AQD Series.
b. Altronix (AS) - Maximal 3.

2.18 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. 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. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.5 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.6 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.7 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. MR - Markar
4. SU - Securitron
5. RO - Rockwood
6. AD - Adams Rite
7. SA - SARGENT
8. RF - Rixson
9. OT - Other

Hardware Sets

Set: CS-1.0

Doors: A100E, A100F, C100A.2, ST00B1.1

1	Continuous Hinge	CFM_SLF-HD1 x Length Required		PE	087100
1	Narrow Rim Exit Device w/Pull (NL, CD)	16 72 PE8504 863 (Cyl. Dogging)	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100

1 Drop Plate	351D (as required)	EN	SA	087100
1 Blade Stop Spacer Kit	581-1 or 2 (as required)	EN	SA	087100
1 Gasketing	Provided By Door/Frame Supplier		OT	
1 Sweep	3452CNB x Length Required		PE	087100
1 Threshold	273x224AFGT MSES25SS x Length Required		PE	087100

Notes: Weatherstrip by Aluminum Door Manufacturer.

Set: CS-2.0

Doors: 1234, 1235, XE0001

1 Continuous Hinge	CFM_SLF-HD1 x Length Required		PE	087100
1 Mortise Deadlock	MS1850S 1-1/8" BS 1	628	AD	087100
1 Thumb Turn Cylinder	4066	130	AD	087100
1 SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1 Push Bar & Pull	BF15847 HD Back-to-Back Mount	US32D-316	RO	087100
1 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1 Drop Plate	351D (as required)	EN	SA	087100
1 Blade Stop Spacer Kit	581-1 or 2 (as required)	EN	SA	087100
1 Gasketing	Provided By Door/Frame Supplier		OT	
1 Sweep	3452CNB x Length Required		PE	087100
1 Threshold	175A MSES25SS x Length required		PE	087100

Notes: Perimeter Weatherstrip by the Aluminum Door Manufacturer.
Mount Push/Pull so as to not interfere with latchbolt/deadbolt function. Interior is the Keyed Side with Thumbturn on the Exterior to prevent locking a person on the Roof or in Garden.

Signage on Doors; not less than 1" Letters "THIS DOOR TO REMAIN UNLOCKED WHEN THE BUILDING IS OCCUPIED"

Set: CS-3.0

Doors: A107, D000N

2 Continuous Hinge (w/PT Prep)	CFM_SLF-HD1 PT x Length Required		PE	087100
2 Electric Power Transfer	EL-CEPT	630	SU	087100
1 Narrow CVR Exit Device w/Pull (NL, RX, ELR)	LD 55 56 72 ADPE8610 P106 x 863 (Less Dogging)	US32D	SA	087100
1 Narrow CVR Exit Device w/Pull (DMY, RX, ELR)	LD 55 56 ADPE8610 863 (Less Dogging)	US32D	SA	087100
1 Small Format Interchangeable	Match Owners Existing BEST System -	626		087100

	Core	Coordinate with Owner for allowance			
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1	Drop Plate	351D (as required)	EN	SA	087100
1	Blade Stop Spacer Kit	581-1 or 2 (as required)	EN	SA	087100
1	Automatic Opener	6011 / 6021 (As Required)	689	NO	087100
1	Gasketing	Provided By Door/Frame Supplier		OT	
1	Card Reader	By Security Supplier			
2	ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
1	ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
2	Low Profile 36" X 6" Push Plate	638		NO	087100
1	Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1	Power Supply	AQD (Size and Options as required)		SU	087100
1	Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes: Coordinate all Wiring and conduit with electrical contractor.

Operation:
• Doors are normally closed and latched.
• Active leaf Exit Device has Nightlatch Function (Key will retract the exit device latch, door is latched when the key is removed).
• When an authorized card read is detected on the secured side of the door the access control system will momentarily retract the exit device latch and activate the auto operator actuator button on the secured side of the opening.
• Alternate Access after audio/video verification via the Intercom system (by Security) remotely releasing the exit device latch and activating the auto operator to allow authorized remote entry.
• When the actuator button on the secure is pressed (after the authorized card read) the auto operator will open the active leaf door of the pair.
• Egress can be achieved at any time by pushing the actuator button on the unsecured side of the opening to retract the exit device latch on the active leaf and activating the auto operator to open the door.
• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.
open the door.
• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.

Set: CS-4.0

Doors: A100W

1	Continuous Hinge	CFM_SLF-HD1 x Length Required		PE	087100
1	Narrow Rim Exit Device (EO, Less Dogging)	LD PE8510 EO	US32D	SA	087100

1 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1 Drop Plate	351D (as required)	EN	SA	087100
1 Blade Stop Spacer Kit	581-1 or 2 (as required)	EN	SA	087100
1 Gasketing	Provided By Door/Frame Supplier		OT	
1 Sweep	3452CNB x Length Required		PE	087100
1 Threshold	273x224AFGT MSES25SS x Length Required		PE	087100

Notes: Weatherstrip by Aluminum Door Manufacturer.
Exit Only, No Exterior access or hardware.

Set: CS-5.0

Doors: A000A.1, D001.1, ST00C.1

3 Hinge, Full Mortise, Hvy Wt	T4A3386 (NRP and size as required)	US32D	MK	087100
1 Rim Exit Device (STRM, CD)	16 72 PE8804 WEH015 (Cyl. Dogging)	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Gasketing	303AS (Head & Jambs)		PE	087100
1 Rain Guard	346C x Width of Frame Head		PE	087100
1 Sweep	3452CNB x Length Required		PE	087100
1 Threshold	175A MSES25SS x Length required		PE	087100

Set: CS-6.0

Doors: C000N.1

6 Hinge, Full Mortise, Hvy Wt	T4A3386 (NRP and size as required)	US32D	MK	087100
2 Electric Power Transfer	EL-CEPT	630	SU	087100
1 Fire Rated CVR Exit Device (STRM, RX, ELR)	12 55 56 72 MDPE8606 WEH015	US32D	SA	087100
1 Fire Rated CVR Exit Device (EO, RX, ELR)	12 55 56 MDPE8610 EO	US32D	SA	087100
3 SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1 Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1 Automatic Opener	6011 / 6021 (As Required)	689	NO	087100
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2 Astragal	29324CNB x Door Height		PE	087100
1 Gasketing	303AS (Head & Jambs)		PE	087100
1 Rain Guard	346C x Width of Frame Head		PE	087100

2 Sweep	3452CNB x Length Required	PE	087100
1 Threshold	273x224AFGT MSES25SS x Length Required	PE	087100
1 Card Reader	By Security Supplier		
1 ElectroLynx Harness (Door)	QC-C**** x Length Required	MK	087100
1 ElectroLynx Harness (Frame)	QC-C3000P	MK	087100
1 Low Profile 36" X 6" Push Plate	638	NO	087100
1 Position Switch	DPS-MW-BK/GY/WH (as required)	SU	087100
1 Power Supply	AQD (Size and Options as required)	SU	087100
1 Wiring Diagram	Elevation and Point to Point as Specified	OT	

Notes: Coordinate all Wiring and conduit with electrical contractor.

Operation:
• Doors are normally closed and latched.
• Active leaf Exit Device has Nightlatch Function (Key will retract the exit device latch, door is latched when the key is removed).
• When an authorized card read is detected on the secured side of the door the access control system will momentarily retract the exit device latch and activate the auto operator actuator button on the secured side of the opening.
• When the actuator button on the secure is pressed (after the authorized card read) the auto operator will open the active leaf door of the pair.
• Egress can be achieved at any time by pushing the actuator button on the unsecured side of the opening to retract the exit device latch on the active leaf and activating the auto operator to open the door.
• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.
control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.

Set: CS-6.1

Doors: CW000

6 Hinge, Full Mortise, Hvy Wt	T4A3386 (NRP and size as required)	US32D	MK	087100
2 Electric Power Transfer	EL-CEPT	630	SU	087100
1 Fire Rated CVR Exit Device (STRM, RX, ELR)	12 55 56 72 MDPE8606 WEH015	US32D	SA	087100
1 Fire Rated CVR Exit Device (EO, RX, ELR)	12 55 56 MDPE8610 EO	US32D	SA	087100
1 SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100

1 Automatic Opener	6011 / 6021 (As Required)	689	NO	087100
2 Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2 Astragal	29324CNB x Door Height		PE	087100
1 Gasketing	303AS (Head & Jambs)		PE	087100
2 Sweep	3452CNB x Length Required		PE	087100
1 Threshold	273x224AFGT MSES25SS x Length Required		PE	087100
1 Card Reader	By Security Supplier			
2 ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
2 ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
2 Low Profile 36" X 6" Push Plate	638		NO	087100
1 Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1 Power Supply	AQD (Size and Options as required)		SU	087100
1 Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes: Coordinate all Wiring and conduit with electrical contractor.

Operation:
During Normal Business Hours:
• Exit Device Latches are electronically held (Dogged) to allow Push/Pull operation.
• When the actuator button on either side of the opening is pressed the auto operator will open the active leaf door of the pair.
• Manual entry or egress is always available by pushing or pulling either door of the pair.
• The exit devices are fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.

After Normal Business Hours:
• Doors are normally closed and latched.
• Active leaf Exit Device has Nightlatch Function (Key will retract the exit device latch, door is latched when the key is removed).
• When an authorized card read is detected on the secured side of the door the access control system will momentarily retract the exit device latch and activate the auto operator actuator button on the secured side of the opening.
• When the actuator button on the secure is pressed (after the authorized card read) the auto operator will open the active leaf door of the pair.
• Egress can be achieved at any time by pushing the actuator button on the unsecured side of the opening to retract the exit device latch on the active leaf and activating the auto operator to open the door.
• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.
l signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.

Set: CS-6.2

Doors: C003.7

8	Hinge, Full Mortise, Hvy Wt	T4A3386 (NRP and size as required)	US32D	MK	087100
2	Electric Power Transfer	EL-CEPT	630	SU	087100
1	Fire Rated CVR Exit Device (STRM, RX, ELR)	12 55 56 72 MDPE8606 WEH015	US32D	SA	087100
1	Fire Rated CVR Exit Device (EO, RX, ELR)	12 55 56 MDPE8610 EO	US32D	SA	087100
1	SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1	Automatic Opener	6011 / 6021 (As Required)	689	NO	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2	Astragal	29324CNB x Door Height		PE	087100
1	Gasketing	303AS (Head & Jambs)		PE	087100
2	Sweep	3452CNB x Length Required		PE	087100
1	Threshold	273x224AFGT MSES25SS x Length Required		PE	087100
1	Card Reader	By Security Supplier			
2	ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
2	ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
2	Low Profile 36" X 6" Push Plate	638		NO	087100
2	Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1	Power Supply	AQD (Size and Options as required)		SU	087100
1	Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes: Coordinate all Wiring and conduit with electrical contractor.

Operation:
• Doors are normally closed and latched.
• Active leaf Exit Device has Nightlatch Function (Key will retract the exit device latch, door is latched when the key is removed).
• When an authorized card read is detected on the secured side of the door the access control system will momentarily retract the exit device latch and activate the auto operator actuator button on the secured side of the opening.
• Alternate Access after audio/video verification via the Intercom system (by Security) remotely releasing the exit device latch and activating the auto operator to allow authorized remote entry.
• When the actuator button on the secure is pressed (after the authorized card read) the auto operator will open the active leaf door of the pair.
• Egress can be achieved at any time by pushing the actuator button on the unsecured side of the opening to retract the exit device latch on the active leaf and activating the auto operator to open the door.
• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.

• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.
open the door.
• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.

Set: CS-7.0

NOT USED

6 Hinge, Full Mortise, Hvy Wt	T4A3386 (NRP and size as required)	US32D	MK	087100
1 Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2 Astragal	29324CNB x Door Height		PE	087100
1 Gasketing	303AS (Head & Jambs)		PE	087100
1 Rain Guard	346C x Width of Frame Head		PE	087100
2 Sweep	3452CNB x Length Required		PE	087100
2 Threshold	175A MSES25SS x Length required		PE	087100

Set: CS-8.0

Doors: PH800.3

3 Hinge, Full Mortise, Hvy Wt	T4A3386 (NRP and size as required)	US32D	MK	087100
1 Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1 SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1 Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Gasketing	303AS (Head & Jambs)		PE	087100
1 Rain Guard	346C x Width of Frame Head		PE	087100
1 Sweep	3452CNB x Length Required		PE	087100
1 Threshold	175A MSES25SS x Length required		PE	087100

Notes: Interior (Push Side) is the Keyed Side of the door, Free Egress from the Roof at all times.

Set: CS-9.0

Doors: B000N.2

2	Continuous Hinge	CFM_SLF-HD1 x Length Required		PE	087100
1	Narrow CVR Exit Device (CLRM, CD)	16 72 ADPE8413 NEH015 (Cyl. Dogging)	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
2	Drop Plate	351D (as required)	EN	SA	087100
2	Blade Stop Spacer Kit	581-1 or 2 (as required)	EN	SA	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Gasketing	Provided By Door/Frame Supplier		OT	

Set: CS-10.0

Doors: C000N.2

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
2	Hinge, Full Mortise, Hvy Wt (PWR TRNS)	T4A3786 QCx (# of Wires and Size as Required)	US26D	MK	087100
1	Fire Rated CVR Exit Device (STRM, RX, ELR)	12 55 56 72 MDPE8606 WEH015	US32D	SA	087100
1	Fire Rated CVR Exit Device (EO, RX)	12 55 MDPE8610 EO	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100
1	Card Reader	By Security Supplier			
2	ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
2	ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
2	Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1	Power Supply	AQD (Size and Options as required)		SU	087100
1	Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes:
Operation:
• Doors are normally closed and latched.
• Active leaf Exit Device has Nightlatch Function (Key will release the exit trim lever to allow entry, trim is locked when the key is removed).
• When an authorized card read is detected on the secured side of the door the access control system will momentarily retract the exit device latch to allow authorized entry before relocking.

• Manual egress is always available by pressing either exit device push bar of the pair. Request to Exit Switch in Exit Device push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.
evice push bar will signal an authorized egress to access control system.
• The exit device is fail secure and will latch in the absence of power.
• Door position switches at each leaf will signal the doors OPEN/CLOSED status to the access control panel.

Set: CS-11.0

Doors: TL0003

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated CVR Exit Device (STRM)	12 72 MDPE8606 WEH015	US32D	SA	087100
1	Fire Rated CVR Exit Device (EO)	12 MDPE8610 EO	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-12.0

Doors: B003A.1, B003C.1

8	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated CVR Exit Device (STRM)	12 72 MDPE8606 WEH015	US32D	SA	087100
1	Fire Rated CVR Exit Device (EO)	12 MDPE8610 EO	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-13.0

Doors: D001.2

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100

1	Fire Rated CVR Exit Device (STRM)	12 72 MDPE8606 WEH015	US32D	SA	087100
1	Fire Rated CVR Exit Device (EO)	12 MDPE8610 EO	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-14.0

Doors: B003A1.1, PH801.2

8	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated CVR Exit Device (STRM)	12 72 MDPE8606 WEH015	US32D	SA	087100
1	Fire Rated CVR Exit Device (EO)	12 MDPE8610 EO	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-15.0

Doors: B003A.3, B003B, B003C.2, C004, CSA00E, CSA00K, CSA01D, CSA01E, CSA02E, CSA03C, CSA03E, CSA04C, CSA04E, CSA05D, CSA05E, CSA06C, CSA06E, CSA07C, CSA07E, CSB00A, CSB00D, CSB01A, CSB01D, CSB02A, CSB02D, CSB03A, CSB03D, CSB04A, CSB05A, CSB05D, CSB06A, CSB07A, ST00C.2, ST08C

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated Rim Exit Device (STRM)	12 72 PE8806 WEH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-16.0

Doors: B003A1.2, CSC01A, PH801.1

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated Rim Exit Device (STRM)	12 72 PE8806 WEH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-17.0

Doors: TL0002

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
2	Fire Rated SVR Exit Device (EO, LBR)	12 NBPE8710 EO	US32D	SA	087100
2	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
4	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2	Electromagnetic Holder	998 x Voltage as Required	689	RF	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Notes: Kick Plates on Both Sides of the Doors
Operation:
Doors normally held open by electromagnetic holders and will be released to close upon activation of fire alarm.
Power to electromagnetic holders and relay to fire alarm by others.

Set: CS-18.0

NOT USED

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
2	Fire Rated CVR Exit Device (CLRM, LBR)	12 NB 72 MDPE8613 WEH015	US32D	SA	087100
2	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
2	Adhesive Astragal	S771C x Door Height		PE	087100
2	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-19.0

Doors: B100N.1, B100N.2, B200N.1, B300N.1, B400N.1, B500N.1, B600N.1, B700N.1, ST00B1.2, ST00B1.3, ST01A

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
2	Fire Rated CVR Exit Device (CLRM, LBR)	12 NB 72 MDPE8613 WEH015	US32D	SA	087100
2	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2	Electromagnetic Holder	998 x Voltage as Required	689	RF	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Notes: Operation:
Doors normally held open by electromagnetic holders and will be released to close upon activation of fire alarm.
Power to electromagnetic holders and relay to fire alarm by others.

Set: CS-20.0

Doors: B300N.2, B400N.2, B500N.2, B600N.2, B700N.2

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated Rim Exit Device (CLRM)	12 72 PE8813 WEH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Electromagnetic Holder	998 x Voltage as Required	689	RF	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Notes: Operation:
Doors normally held open by electromagnetic holders and will be released to close upon activation of fire alarm.
Power to electromagnetic holders and relay to fire alarm by others.

Set: CS-21.0

Doors: ST00B, ST01B, ST01C, ST02A, ST02B, ST02C, ST03A, ST03B, ST03C, ST04A, ST04B, ST04C, ST05A, ST05B, ST05C, ST06A, ST06B, ST06C, ST07A, ST07B, ST07C, ST08B

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Fire Rated Rim Exit Device (PASS)	12 PE8815 WEH015	US32D	SA	087100

1 Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1 Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-22.0

Doors: C003.1

5 Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1 Hinge, Full Mortise, Hvy Wt (PWR TRNS)	T4A3786 QCx (# of Wires and Size as Required)	US26D	MK	087100
1 Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Electrified Mortise Lock (Fail Sec., RX)	72 NAC-82271-24v LNH015	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2 Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
2 Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2 Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1 Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100
1 Card Reader	By Security Supplier			
1 ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
1 ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
1 Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1 Power Supply	AQD (Size and Options as required)		SU	087100
1 Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes: System Operational Narrative:
• Door normally closed and secure.
• Electrified Lockset has Storeroom Function (Key will retract latch to open door, door is locked when the key is removed).
• Access by valid credential presentation releasing the lockset lever to allow authorized entry and then relocking.
• Egress always free for immediate exit. Request-to-Exit sensor allows exit without alarm condition.
• Door position switch provides open/closed monitoring to both access control system and intrusion alarm service.
• Lockset Lever remains locked (fail secure) in event of power loss.
alarm service.
• Lockset Lever remains locked (fail secure) in event of power loss.

Set: CS-23.0

Doors: C001.1

5	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Hinge, Full Mortise, Hvy Wt (PWR TRNS)	T4A3786 QCx (# of Wires and Size as Required)	US26D	MK	087100
1	Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1	Dust Proof Strike	570	US26D	RO	087100
1	Electrified Mortise Lock (Fail Sec., RX)	72 NAC-82271-24v LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100
1	Card Reader	By Security Supplier			
1	ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
1	ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
1	Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1	Power Supply	AQD (Size and Options as required)		SU	087100
1	Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes: System Operational Narrative:
• Door normally closed and secure.
• Electrified Lockset has Storeroom Function (Key will retract latch to open door, door is locked when the key is removed).
• Access by valid credential presentation releasing the lockset lever to allow authorized entry and then relocking.
• Egress always free for immediate exit. Request-to-Exit sensor allows exit without alarm condition.
• Door position switch provides open/closed monitoring to both access control system and intrusion alarm service.
• Lockset Lever remains locked (fail secure) in event of power loss.
alarm service.
• Lockset Lever remains locked (fail secure) in event of power loss.

Set: CS-24.0

Doors: C002, C003B.1, C003B.2

4	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
2	Hinge, Full Mortise, Hvy Wt (PWR TRNS)	T4A3786 QCx (# of Wires and Size as Required)	US26D	MK	087100
1	Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1	Dust Proof Strike	570	US26D	RO	087100
1	Electrified Mortise Lock (Fail	72 NAC-82271-24v LNH015	US32D	SA	087100

	Sec., RX)				
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2	Surf Overhead Stop	10-X36 (Size as Required)	630	RF	087100
2	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100
1	Card Reader	By Security Supplier			
1	ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
1	ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
1	Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100
1	Power Supply	AQD (Size and Options as required)		SU	087100
1	Wiring Diagram	Elevation and Point to Point as Specified		OT	

Notes: System Operational Narrative:
• Door normally closed and secure.
• Electrified Lockset has Storeroom Function (Key will retract latch to open door, door is locked when the key is removed).
• Access by valid credential presentation releasing the lockset lever to allow authorized entry and then relocking.
• Egress always free for immediate exit. Request-to-Exit sensor allows exit without alarm condition.
• Door position switch provides open/closed monitoring to both access control system and intrusion alarm service.
• Lockset Lever remains locked (fail secure) in event of power loss.
alarm service.
• Lockset Lever remains locked (fail secure) in event of power loss.

Set: CS-25.0

Doors: C005

1	Continuous Hinge	HG3505 CTP WEP AS x Length as Required	630	MR	087100
1	Electric Power Transfer	EL-CEPT	630	SU	087100
1	Electrified Mortise Lock (Fail Sec., RX)	72 NAC-82271-24v LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
1	Kick Plate (Adhesive Mount)	K1050 10" high SA BEV	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100
1	Card Reader	By Security Supplier			
1	ElectroLynx Harness (Door)	QC-C**** x Length Required		MK	087100
1	ElectroLynx Harness (Frame)	QC-C3000P		MK	087100
1	Position Switch	DPS-MW-BK/GY/WH (as required)		SU	087100

1 Power Supply	AQD (Size and Options as required)	SU		087100
1 Wiring Diagram	Elevation and Point to Point as Specified	OT		

Notes:
Operation:
• Door is normally closed and latched. Lockset allows Keyed Access, Locked when key is removed.
• An authorized credential presentation the card reader will release the lever to allow authorized entry and then relock.
• Manual egress is always available by turning the lever on the unsecure side. Request to exit switch will signal an authorized egress to the access control system.
• Door position switch will signal the doors OPEN/CLOSED status to the access control panel.
• The Lockset is fail secure and will remain locked on activation of fire alarm or in the absence of power. secure and will remain locked on activation of fire alarm or in the absence of power.

Set: CS-26.0

Doors: PH800.2

6 Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1 Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1 SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
2 Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2 Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2 Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
2 Silencer	608		RO	087100

Set: CS-27.0

Doors: PH800.1

8 Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1 Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1 SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1 Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
2 Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2 Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
2 Silencer	608		RO	087100

Set: CS-28.0

Doors: B801

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1	Dust Proof Strike	570	US26D	RO	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Coordinator	2600 Series x Mounting Brackets As Required	Black	RO	087100
2	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-29.0

Doors: PH802.3

8	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1	Dust Proof Strike	570	US26D	RO	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Coordinator	2600 Series x Mounting Brackets As Required	Black	RO	087100
2	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
2	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-30.0

Doors: C003.2, C003C, C006A

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1	Dust Proof Strike	570	US26D	RO	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100

1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Coordinator	2600 Series x Mounting Brackets As Required	Black	RO	087100
2	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
2	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-31.0

Doors: C001.2, C006

6	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Self Latching Flush Bolt Set	2845 / 2945 (as required)	US26D	RO	087100
1	Dust Proof Strike	570	US26D	RO	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Coordinator	2600 Series x Mounting Brackets As Required	Black	RO	087100
2	Conc Overhead Stop	1-X36 (Size as Required)	630	RF	087100
2	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
2	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Adhesive Astragal	S771C x Door Height		PE	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-32.0

Doors: B005H, CSA00A, CSA00H, CSA00J, CSA01A, CSA02A, CSA03A, CSA04A, CSA05A, CSA06A, CSA07A, D000N1, PH804

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
3	Silencer	608		RO	087100

Set: CS-32.1

Doors: B003B1.1, B003B1.2, B003C1.1, B003C1.2

3	Hinge, Full Mortise, Hvy Wt (Wide Throw)	T4A3786 (NRP and Size as Required)	US26D	MK	087100

1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
3	Silencer	608		RO	087100

Notes: Doors Open to 180 Degrees.
Wide Throw Hinge to Clear Furred Wall - Verify Size Requirements

Set: CS-33.0

Doors: C007, CSB01B, CSB02B

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
3	Silencer	608		RO	087100

Set: CS-34.0

Doors: CSB04B, CSB05B, CSB06B, CSB07B, CSB30B

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	SFIC Mortise Cylinder	Size and Cam as Required	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surf Overhead Stop	10-X36 (Size as Required)	630	RF	087100
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
3	Silencer	608		RO	087100

Set: CS-35.0

Doors: A000A.2, B003A, C000N1, C003A, CSA00B, CSA00F, CSA01B, CSA02B, CSA03B, CSA04B, CSA05B, CSA06B, CSA07B, CSB00B, CSB00C, CSB01C, CSB02C, CSB05C, PH802.1, PH803, PH807, ST08C1

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable	Match Owners Existing BEST System -	626		087100

	Core	Coordinate with Owner for allowance			
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-36.0

Doors: CSA00G.1, CSA00G.2, PH805, PH806

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer	351 CPS (HD Cush STP Arm)	EN	SA	087100
1	Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-37.0

Doors: B005J, CSA02C, CSB03C, CSB04C, CSB06C, CSB07C

3	Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1	Storeroom/Closet Lock	72 8204 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surf Overhead Stop	10-X36 (Size as Required)	630	RF	087100
1	Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-38.0

Doors: C001A.1, C001B.1

3	Hinge, Full Mortise	TA2714 (NRP and size as required)	US26D	MK	087100
1	Office/Entry Lock	72 8205 LNH015	US32D	SA	087100
1	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	Surface Closer (Tri-Pack)	351 UO Lead Line Cover	EN	SA	087100
1	Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1	Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
1	Adhesive Perimeter Gasketing	S88BL (Head & Jambs)		PE	087100

Set: CS-39.0

Doors: C000N3

3 Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1 Privacy Lock	V21 8265 LNH015	US26D	SA	087100
1 Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1 Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
1 Wall or Floor Stop (as Required)	403 (or) 441CU (As Required)	US26D	RO	087100
3 Silencer	608		RO	087100
1 Coat Hook	RM801	US26D	RO	087100

Set: CS-40.0

Doors: C000N2

3 Hinge, Full Mortise, Hvy Wt	T4A3786 (NRP and size as required)	US26D	MK	087100
1 Privacy Lock	V21 8265 LNH015	US26D	SA	087100
1 Surf Overhead Stop	10-X36 (Size as Required)	630	RF	087100
1 Surface Closer (Tri-Pack)	351 UO (Ra or PA Mount as Required)	EN	SA	087100
1 Kick Plate	K1050 10" high BEV CSK	US32D	RO	087100
3 Silencer	608		RO	087100
1 Coat Hook	RM801	US26D	RO	087100

Set: CS-41.0

Doors: A100A.1, B003A.2, C001.3, C001.4, C001.5, C001.6, C001.7, C003.3, C003.4, C003.5, C003.6, C100A.1, C100A.3, ST00D

2	Small Format Interchangeable Core	Match Owners Existing BEST System - Coordinate with Owner for allowance	626		087100
1	SFIC Cylinder	type as required	US32D	SA	087100
1		All Hardware Provided By Door Supplier			

END OF SECTION 087100

SECTION 088000 – GLAZING - EXTERIOR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Insulating glass.
3. Glazing sealants.
4. Glazing tapes.
5. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 084413 "Glazed Aluminum Curtain Walls".

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include sealant manufacturer's temperature and substrate requirements.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square. For insulating glass units, provide assemblies representative of units to be used in the finished work, including coatings, spacers, edge seals, and edge deletion. Include gaskets, setting blocks, shims, and other glazing accessories.

D. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of adjoining framing system.

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturers of fabricated glass units, glass testing agency and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For fabricated glass and glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
2. Include the glass fabricator/manufacturer's calculations for wind pressure and thermal stress showing that the specified probabilities of breakage are not exceeded.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

F. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved and certified by primary glass manufacturer.

B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Install glazing in mockups specified in Section 084413 "Glazed Aluminum Curtain Walls" to match glazing systems required for Project, including glazing methods.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD 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 glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cardinal Glass Industries.
2. Guardian Glass; SunGuard.
3. Pilkington North America.
4. Viracon, Inc.
5. Vitro Architectural Glass.

B. Source Limitations for Glass: Obtain coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on heights above grade indicated on Drawings.

    a. Wind Design Data: As indicated on Drawings.

2. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for glass installed vertically or not more than 15 degrees from the vertical plane and under wind action.

    a. Load Duration: 60 seconds or less.

3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
4. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

D. Safety Glazing: Where safety glazing is indicated or required by code, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. Performance requirements for glazing including, but not limited to, visible transmittance and sound requirements.
2. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: 6 mm.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Low-Iron Annealed Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent and SHGC of not less than 0.87.

B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Roller distortion or ripples shall run in the same direction for the entire job. Roller distortion, measured peak to valley, shall not exceed 0.003 inches in the central area for 1/4 inch or thicker glass, or 0.008 inches within 10.5 inches of the leading or trailing edge for 1/4 inch or thicker glass. Clear or low-iron glass ¼” to 3/8” thick without ceramic frit or ink, maximum + or – 100 mD (millidiopter) over 95% of the glass surface. Local bow shall not exceed 1/32 inch in 12 inches.

2. Heat Soak Testing: Unless manufacturer’s standard procedures are more stringent, perform heat soak testing of all fully tempered glass lites by placing glass in an oven at temperatures of 550dF,+/-50dF for a two hour “Dwell Time” to reduce the potential for spontaneous breakage to 5 lites per 1000 (5/1000).

C. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Roller distortion or ripples shall run in the same direction for the entire job. Roller distortion, measured peak to valley, shall not exceed 0.003 inches in the central area for 1/4 inch or thicker glass, or 0.008 inches within 10.5 inches of the leading or trailing edge for 1/4 inch or thicker glass. Clear or low-iron glass ¼" to 3/8" thick without ceramic frit or ink, maximum + or – 100 mD (millidiopter) over 95% of the glass surface. Local bow shall not exceed 1/32 inch in 12 inches.

D. Pyrolytic-Coated Glass: Clear float glass with coating on first surface.

E. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

F. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.

G. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with polyisobutylene and silicone primary and secondary sealants.
2. Perimeter Spacer: Fabricators warm edge spacer. Color: Black.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from the following:

1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
3. Silicone complying with ASTM C 1115.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.7 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they 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 of industry colors.

B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; 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; and complying with ASTM C1281 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; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by 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:

1. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks:

1. Type recommended in writing by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit 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.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, 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 systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 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. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. 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.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

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- (3-mm-) 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.

G. 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 in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

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 in writing by gasket manufacturer.

3.4 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, then to jambs. Cover horizontal framing joints by applying tapes to jambs, 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 right 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.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to 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. Installation with Drive-in Wedge Gaskets: 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 in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 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.

3.7 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. 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.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces 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.

3.8 INSULATING GLASS SCHEDULE

A. Low-E-Coated, Low-Iron Clear Insulating Glass Type (GL-21):

1. Basis-of-Design Product: Vitro Architectural Glass; Solarban 90 Acuity Series.
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Low-iron fully tempered float glass.
5. Interspace Content: Argon.
6. Indoor Lite: Low-iron fully tempered float glass.
7. Low-E Coating: Sputtered on second surface.
8. Winter Nighttime U-Factor: 0.24 maximum.
9. Visible Light Transmittance: 63 percent minimum.
10. SGHC: 0.23 maximum.
11. Safety glazing required.

B. Lightly Reflective Low-E-Coated, Low-Iron Clear Insulating Glass Type (GL-22):

1. Basis-of-Design Product: Vitro Architectural Glass; Solarban R100 Acuity Series.
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Low-iron fully tempered float glass.
5. Interspace Content: Argon.
6. Indoor Lite: Low-iron fully tempered float glass.
7. Low-E Coating: Sputtered on second surface. Color to match Architect’s sample.

8. Winter Nighttime U-Factor: 0.25 maximum.
9. Visible Light Transmittance: 43 percent minimum.
10. SGHC: 0.23 maximum.
11. Safety glazing required.

C. Low-E-Coated, Low-Iron Clear Insulating with Birdsafe UV Coating Glass Type (GL-23):

1. Basis-of-Design Product: Vitro Architectural Glass; Solarban 90 Acuity Series with Walker Glass AviProtek T Pattern 713 (vertical orientation) Bird Safe UV Coating.
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Bird safe pyrolytic UV coating on No. 1 surface, clear low-iron fully tempered float glass.
5. Interspace Content: Argon.
6. Indoor Lite: Low-iron fully tempered float glass.
7. Low-E Coating: Sputtered on second surface. Color to match Architect's sample.
8. Winter Nighttime U-Factor: 0.24 maximum.
9. Visible Light Transmittance: 63 percent minimum.
10. SGHC: 0.23 maximum.
11. Safety glazing required.

D. Silicone-Coated, Low-E, Insulating Spandrel Glass Type (GL-41):

1. Basis-of-Design Product: Vitro Architectural Glass; Solarban 90 Acuity Series.
2. Coating Color: OPACI-COAT-300, *2-3867LI Fields of Emerald.*
3. Overall Unit Thickness: 1 inch (25 mm).
4. Minimum Thickness of Each Glass Lite: 6 mm.
5. Outdoor Lite: Low-iron heat-strengthened float glass.
6. Interspace Content: Air.
7. Indoor Lite: Low-iron fully tempered float glass.
8. Low-E Coating: Sputtered on second surface.
9. Opaque Coating Location: Fourth surface.

E. Silicone-Coated, Lightly Reflective, Low-E, Insulating Spandrel Glass Type (GL-42):

1. Basis-of-Design Product: Vitro Architectural Glass; Solarban R100 Acuity Series.
2. Coating Color: OPACI-COAT-300, *6-4029LI Ocean Horizon.*
3. Overall Unit Thickness: 1 inch (25 mm).
4. Minimum Thickness of Each Glass Lite: 6 mm.
5. Outdoor Lite: Low-iron heat-strengthened float glass.
6. Interspace Content: Air.
7. Indoor Lite: Low-iron fully tempered float glass.
8. Low-E Coating: Sputtered on second surface.
9. Opaque Coating Location: Fourth surface.

END OF SECTION 088000

SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed extruded-aluminum louvers.
2. Blank-off panels for louvers

1.2 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Project specific. For louvers and accessories. Include plans, elevations, sections, details, integration with surrounding construction and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

D. Samples: For each type of metal finish required.

E. Delegated Design Submittal: For louvers indicated to comply with structural performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

B. Sample Warranties: For manufacturer's special warranties.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.

1. Wind Loads:

a. Determine loads based on pressures as indicated on Drawings.

C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Drainable-Blade Louver, Extruded Aluminum: (LVR-1A, LVR-1B, *LVR-1C*, ~~*LVR-2*~~)

1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Model A6097 or a comparable product by one of the following:

a. Airolite Company, LLC (The); Model K6846.
b. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.; Model ELF6350DMP.

2. Louver Depth: 6 inches (150 mm).
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm).
4. Mullion Type: Continuous blade with concealed vertical and horizontal supports for seamless appearance.
5. Louver Performance Ratings:

a. Free Area: Not less than 8.34 sq. ft. (0.775 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
b. Point of Beginning Water Penetration: Not less than 1100 fpm (5.6 m/s).
c. Air Performance:

1) Not more than 0.10-inch wg (25-Pa) static pressure drop at 800-fpm (4.1-m/s) free-area intake velocity.
2) Not more than 0.15-inch wg (37-Pa) static pressure drop at 1000-fpm (5.1-m/s) free-area exhaust velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

B. Horizontal Drainable-Blade Louver, Extruded Aluminum (LVR-3 & LVR-2):

1. *Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; Model A4097 or a comparable product by one of the following:*

    a. *Airolite Company, LLC (The).*
    b. *Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.*

2. *Louver Depth: 4 inches (100 mm).*
3. *Frame and Blade Nominal Thickness: Not less than 0.068 inch (1.73 mm) for blades and 0.080 inch (2.03 mm) for frames.*
4. *Mullion Type: Continuous blade with concealed vertical and horizontal supports for seamless appearance.*
5. *Louver Performance Ratings:*

    a. *Free Area: Not less than 8.07 sq. ft. (0.750 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.*
    b. *Point of Beginning Water Penetration: Not less than 1040 fpm (5.3 m/s).*
    c. *Air Performance:*

        1) *Not more than 0.20-inch wg static pressure drop at 1040-fpm (5.3-m/s) free-area intake velocity.*
        2) *Not more than 0.18-inch wg static pressure drop at 1000-fpm (5.1-m/s) free-area exhaust velocity.*

6. *AMCA Seal: Mark units with AMCA Certified Ratings Seal.*

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with stainless steel machine screws, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Non-rewirable, U-shaped frames.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening, Flattened, Expanded Aluminum: 5/8 by 0.055 inch (15.87 by 1.4 mm) thick.

2.5 BLANK-OFF PANELS

A. Insulated Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 3 inches (76.2 mm).
2. Metal Facing Sheets, Aluminum: Not less than 0.032-inch (0.81-mm) nominal thickness.
3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets.
6. Panel Finish: Interior side: mill finish, exterior side: Kynar 500 Black.
7. Attach blank-off panels with clips or sheet metal screws.
8. Provide full blank-off panels as indicated on Drawings.

2.6 MATERIALS

A. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B209 (ASTM B209M), Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. For fastening aluminum, use stainless steel fasteners.
2. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

F. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

G. Regional Materials: Manufacture products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

2.7 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

2. Louvers to be supplied with 4-inch (101.6 mm) high by full depth sill flashing formed from minimum 0.050 inch (1.27 mm) thick aluminum.
3. Sill flashing to have welded side panels.
4. At LVR-2, provide glazing channel receiver(s) for integration into unitized curtain wall system.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades for seamless appearance. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.

F. Provide subsills made of same material as louvers or extended sills for recessed louvers.

G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer mica finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions .
2. Color and Gloss: Custom colors. Match Architect's samples. ~~*LVR-1B &*~~ LVR-2 ~~*& LVR-3*~~ to match CW-1, LVR-1A to match FBR-2, *LVR-1C to match FBR-1A,* *LVR-1B & LVR-3 to match MP-2*.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, 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.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089119

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

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. Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each component of gypsum board shaft wall assembly.

B. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.4 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 support them on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.

B. Do not install finish panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and 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

2.1 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 E119 by an independent testing agency.

B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated on Drawings.

B. STC Rating: As indicated on Drawings.

C. Gypsum Shaftliner Board (GYP BD-21):

1. Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, 1 inch (25.4 mm) thick, and with double beveled long edges.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) CertainTeed Corporation; Saint-Gobain North America; GlasRoc Shaftliner Type X.
        2) Georgia-Pacific Gypsum LLC; DensGlass Shaftliner.
        3) National Gypsum Company; Gold Bond eXP Shaftliner.
        4) USG Corporation; Sheetrock Brand Glass-Mat Liner Panels.

D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.

1. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.

E. Studs (MET STUD-2): Manufacturer's standard profile for repetitive, corner, and end members as follows:

1. Depth: As indicated on Drawings.
2. Minimum Base-Metal Thickness: As indicated on Drawings.

F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (51 mm) long and matching studs in depth.

1. Minimum Base-Metal Thickness: Matching steel studs.

G. 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, provide one of the following:

a. ClarkDietrich; MaxTrak.
b. Fire Trak Corp; Fire Track System.
c. GCP Applied Technologies Inc.; FlameSafe FlowTrak System.
d. Metal-Lite; The System.
e. The Steel Network, Inc.; VertiTrack VTD.

H. Elevator-Hoistway-Entrance Struts: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches (76 mm), matching studs in depth, and not less than 0.033 inch (0.84 mm) thick.

I. Finish Panels: Gypsum board as specified in Section 092900 "Gypsum Board."

J. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.

E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch (0.84-mm) minimum thickness of base metal (uncoated).

F. Acoustical Sealant: Section 079219 "Acoustical Joint Sealants."

G. Gypsum Board Cants:

1. Gypsum Board Panels: As specified in Section 092900 "Gypsum Board," Type X, 1/2- or 5/8-inch (13- or 16-mm) panels.
2. Adhesive: Laminating adhesive as specified in Section 092900 "Gypsum Board."
3. Non-Load-Bearing Steel Framing: As specified in Section 092216 "Non-Structural Metal Framing."

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 the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 078100 "Applied Fire Protection."

B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.

B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
2. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings; accurately position and secure behind at least one layer of face panel.

D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection

behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.

E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.

F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

G. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

I. Gypsum Board Cants: At projections into shaft exceeding 4 inches (102 mm), install gypsum board cants covering tops of projections.

1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft wall framing.
2. Where non-load-bearing steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft wall framing.

J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.4 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and 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 092116.23

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior non-load-bearing wall studs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For embossed, high-strength steel studs and tracks, firestop tracks, post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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 E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Horizontal Deflection:

1. Typical Partitions: L/240 at 5 lb/sq ft (239 Pa) lateral load.
2. Elevator Shaft Partitions: L/240 at 7.5 lb/sq ft (359 Pa) lateral load.
3. Partitions with Tile Facing: L/360 at 7.5 lb/sq ft (359 Pa) lateral load.
4. Partitions supporting Lead Lined Doors and Frames: Provide delegated engineering to comply with L/480 at 10 lb/sq ft (479 Pa) lateral load.
5. Partitions supporting all other Concentrated Loads: Provide delegated engineering to comply with L/360 at 10 lb/sq ft (479 Pa) lateral load.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
2. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated. No equivalent coatings allowed.

B. Studs and Tracks (MET STUD-1): ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.

1. Steel Studs and Tracks:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) JN Linrose.
2) MarinoWARE.
3) MBA Building Supplies.
4) MRI Steel Framing, LLC.
5) Telling Industries.
6) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: As indicated on Drawings.
c. Depth: As indicated on Drawings.

2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ClarkDietrich.
2) MarinoWARE.
3) MBA Building Supplies.
4) Steel Construction Systems.
5) Telling Industries.
6) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: 0.0190 inch (0.483 mm).
c. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Track System: ASTM C645 top track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
3. Deflection Track: Steel sheet top track 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; MaxTrak Slotted Deflection Track.
2) MarinoWARE.
3) Metal-Lite.
4) Steel Construction Systems; Steel-Con Slotted Leg Track System.
5) Telling Industries; Vertical Slip Track.
6) The Steel Network, Inc.; VertiClip SLD.

D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of 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, provide one of the following:

a. ClarkDietrich; BlazeFrame.
b. Fire Trak Corp; Fire Trak System attached to studs with Fire Trak Posi Klip.
c. MarinoWARE.
d. Metal-Lite.
e. Steel Construction Systems; Steel-Con Slotted Leg Track System.
f. The Steel Network, Inc.; VertiTrack VT.

E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C645.

1. Minimum Base-Steel Thickness: As indicated on Drawings.
2. Depth: As indicated on Drawings.

G. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical.

H. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-steel thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.

J. Radius Framing: Steel sheet runner for non-load-bearing curves, bends, variable radii, and arches.

1. Basis-of-Design Product: Subject to compliance with requirements, provide ClarkDietrich; 360TRAK or comparable product

2. Minimum Base-Steel Thickness: As indicated on Drawings.
3. Depth: As indicated on Drawings.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.

a. Uses: Securing hangers to structure.
b. Type: Torque-controlled, expansion anchor torque-controlled, adhesive anchor or adhesive anchor.
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
2. Steel Studs and Tracks: ASTM C645.

a. Minimum Base-Steel Thickness: As indicated on Drawings.
b. Depth: As indicated on Drawings.

3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.

a. Minimum Base-Steel Thickness: As indicated on Drawings.
b. Depth: As indicated on Drawings.

4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch (22 mm) deep.

a. Minimum Base-Steel Thickness: As indicated on Drawings.

5. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.

a. Configuration: Asymmetrical.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armstrong Ceiling & Wall Solutions; Drywall Grid Systems and QuikStix Drywall Soffit Framing System.
b. Rockfon (Rockwool International); 640/660 Drywall Ceiling Suspension.
c. USG Corporation; Drywall Suspension System.

G. Use stainless steel hanger wires in locations subject to moisture penetration or condensation. Other support brackets and framing shall be galvanized steel.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 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.

3.2 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.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks 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 that penetrate 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 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 (13-mm) 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.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.

b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.

E. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm) 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 (610 mm) 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 (305 mm) from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches (1219 mm) o.c.
2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

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.

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. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
8. Locate hangers and supports where they will not interfere with access to mixing boxes, fire dampers, valves, and other appurtenances requiring service.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. 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.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
3. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
4. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Project specific. Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

D. Sustainable Design Submittals:

1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
3. Product Data: For adhesives and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.3 MOCKUPS

A. Build mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for the following:

a. Each level of gypsum board finish indicated for use in exposed locations, including Level 5 finish in areas of critical lighting.

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.

1.4 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.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, 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, 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.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 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 E119 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 E90 and classified according to ASTM E413 by an independent testing agency.

C. Verify ceiling and wall materials comply with the 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."

2.3 GYPSUM BOARD, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Regional Materials: Manufacture products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

C. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.4 INTERIOR GYPSUM BOARD

1. Thickness: As indicated on Drawings.
2. Long Edges: Tapered.

B. Gypsum Board, Type X (GYP BD-1): ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CertainTeed Corporation; Saint-Gobain North America.
    b. Georgia-Pacific Gypsum LLC.
    c. National Gypsum Company.
    d. USG Corporation.

2. Thickness: 5/8 inch (15.9 mm).
3. Long Edges: Tapered.

C. Impact-Resistant Gypsum Board (GYP BD-36): ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corporation; Saint-Gobain North America; CertainTeed Extreme Impact Resistant Type X Gypsum Board with M2Tech Mold and Moisture Technology.

b. Georgia-Pacific Gypsum LLC; DensArmorPlus Impact-Resistant Panels.
c. Gold Bond Building Products, LLC provide by National Gypsum Company; Gold Bond Brand XP Hi-Impact Gypsum Board.
d. USG Corporation; USG Sheetrock Brand Mold Tough VHI (Very High Impact) Firecode Core.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
4. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
6. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements according to test in Annex A1.
7. Long Edges: Tapered.
8. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

D. Mold-Resistant Gypsum Board (GYP BD-2): ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corporation; Saint-Gobain North America; M2Tech Drywall.
b. Georgia-Pacific Gypsum LLC; ToughRock Fireguard X Mold-Guard Gypsum Board.
c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board.
d. USG Corporation; Sheetrock Brand Mold Tough Panels Firecode X.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board (GYP BD-25): ASTM C1178/C1178M, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed; SAINT-GOBAIN; GlasRoc Tile Backer.
b. Georgia-Pacific Gypsum LLC; DensShield Fireguard Type X Tile Backer Board.
c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Tile Backer.
d. USG Corporation; USG Durock Glass-Mat Tile Backerboard.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

    a. Cornerbead.
    b. L-Bead: L-shaped; exposed long flange receives joint compound.
    c. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    d. Expansion (control) joint.
    e. 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, provide products by one of the following:

    a. Fry Reglet Corporation.
    b. Gordon, Inc.
    c. Pittcon Industries.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221 (ASTM B221M), Alloy 6063-T5.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

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, rounded or beveled panel edges, 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.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.8 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Verify adhesives have a VOC content of 50 g/L or less.
2. Verify adhesive complies 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."

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

D. Sound-Attenuation Blankets: ASTM C665, 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: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 35 percent.

E. Acoustical 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, provide one of the following:

a. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
b. Pecora Corporation.
c. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
d. USG Corporation; SHEETROCK Acoustical Sealant.

2. Verify sealant has a VOC content of 250 g/L or less.
3. Verify sealant complies 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."

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

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.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

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 (1.5 mm) 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. (0.7 sq. m) 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- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) 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. 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 C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: Vertical surfaces unless otherwise indicated.
2. Impact-Resistant Type: As indicated on Drawings.
3. 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 vertically (parallel 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-shaped 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 ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. 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.
3. On Z-shaped 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.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum

board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

3.4 INSTALLATION OF TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install where indicated on Drawings. Install with 1/4-inch (6.4-mm) 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.

3.5 INSTALLATION OF 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 at locations indicated on Drawings and according to ASTM C840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. L-Bead: Use where indicated on Drawings.
3. U-Bead: Use at exposed panel edges.
4. Curved-Edge Cornerbead: Use at curved openings.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING OF 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, rounded or beveled edges, 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 C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

5. Level 5: Where recommended by latest publication of the Gypsum Association GA-214 “Recommended Levels of Finish for Gypsum Board, Glass Mat & Fiber-Reinforced Gypsum Panels” and/or where indicated on Drawings. Areas requiring high level of finish must have a pre-installation meeting to assure Contractor understands contract requirements/expectations.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.7 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 092900

SECTION 101426 - POST AND PANEL SIGNAGE

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. Nonilluminated post and panel signs.

B. Related Sections include the following:
   1. Division 01 Section "Temporary Facilities and Controls" for temporary Project identification signs and for temporary informational and directional signs.
   2. Division 03 Section "Cast-in-Place Concrete" for concrete foundations and concrete fill.

1.3 DEFINITIONS

A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for post and panel signage.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Provide message list, typestyles, graphic elements, and layout for each sign at least half size and full-size details of graphics.

C. Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for the following:
   1. Aluminum.

D. Sign Schedule: Use same designations indicated on Drawings.

E. Qualification Data: For fabricator.

F. Maintenance Data: For signs to include in maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.5 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.

B. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

C. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC A117.1.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Indicate measurements on Shop Drawings.

1.7 COORDINATION

A. Coordinate installation of anchorages for post and panel signage. Furnish setting drawings, templates, and directions for installing anchorages and other items that are to be embedded in concrete.

PART 2 - PRODUCTS

2.1 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, and with at least the strength and durability properties of Alloy 5005-H32.

2.2 POST AND PANEL SIGNS

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. Allen Industries Architectural Signage.
2. APCO Graphics, Inc.
3. ASI-Modulex, Inc.
4. Best Sign Systems Inc.
5. Bunting Graphics, Inc.
6. Charleston Industries, Inc.
7. Nelson-Harkins Industries.
8. Signature Signs, Incorporated.
9. Supersine Company (The).

10. Vomar Products, Inc.
11. Peachtree Business Products, Inc.

2.3 PANEL SIGNS

A. Sign Message Panels: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.
   1. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
   2. Increase metal thickness or reinforce with concealed stiffeners or backing materials as needed to produce surfaces without distortion, buckles, warp, or other surface deformations.
   3. Continuously weld joints and seams unless other methods are indicated; grind, fill, and dress welds to produce smooth, flush, exposed surfaces with welds invisible after final finishing.

B. Message Panel Materials:
   1. Aluminum Sheet: 0.080 inch thick.
      a. Panel Finish: Baked enamel.
      b. Color: As selected by Architect from manufacturer's full range.

2.4 POSTS

A. General: Fabricate posts to lengths required for mounting method indicated.
   1. Direct-Embed Method: Provide posts 36 inches longer than height of sign to permit direct embedment in concrete foundations.

B. Galvanized Steel Posts: Manufacturer's standard 0.125-inch- thick, galvanized steel tubing, with vertical slots to engage sign panels. Provide stop blocks in slots to hold panels in position. Include post caps, fillers, spacers, junction boxes, access panels, and related accessories required for complete installation.
   1. Square Posts: 2 inches.
   2. Post Finish: Baked enamel.
   3. Color: As selected by Architect from manufacturer's full range.

2.5 ACCESSORIES

A. Hardware, Anchors and Inserts: Provide type 316 stainless steel hardware, and galvanized steel anchors and inserts, for exterior installations and elsewhere as required for corrosion resistance. Furnish anchors and inserts, as required, to set posts into concrete footings.

2.6 FABRICATION

A. General: Provide manufacturer's standard post and panel signs of configurations indicated.
   1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of

exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.

2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.7 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. 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.

2.8 FINISHES

A. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify that items are sized and located to accommodate signs.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Excavation: Excavate for sign foundation to elevations and dimensions indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating a further 12 inches, backfilling with satisfactory soil, and compacting to original subgrade elevation.

B. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
   1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.

3.3 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION 101426

SECTION 107300 - CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building supported, pre-engineered metal canopies including fascia channels, decking, and attachment hardware.

1.2 REFERENCES

A. American Society of Civil Engineers (ASCE) 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International (ASTM)

1. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
2. B429 - Standard Specification for Aluminum-Alloy Extruded Pipe and Tube.
3. A36 Standard Mild Steel Specification
4. A50/A53 Standards for Structural steel

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design canopy system to withstand:

1. Standards for wind pressure, snow load, and drifting snow load in accordance with current adopted form of the Building Code or accepted requirements of local municipality.

1.4 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Indicate system components, dimensions, attachments, and accessories.
2. Samples:

a. 3 x 3 inch coating samples in specified color.
b. 6 inch long fascia profile sample showing profile and standard finish.
c. 6 inch decking samples showing profile and standard finish.

B. LEED Project Submittals

1. Product Data for Credit MR 4: documentation indicating percentages by weight of post consumer and pre consumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for Credit MR 5: Indicate location of product manufacturer, distance from manufacturer to project site, and mill test report for origination of materials.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years' experience in installation of MASA products.

PART 2 - PRODUCTS

2.1 CANOPY (CNPY-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide MASA Architectural Canopies; Extrudeck Extruded Aluminum Canopy System or comparable product by one of the following;

1. Architectural Shade Products.
2. Mapes Architectural Canopies.
3. Victory Awning, Inc.

2.2 MATERIALS

A. Aluminum Extrusions:

1. ASTM B221& ASTM B429 6063-T5 alloy and temper.

B. Hardware:

1. All fasteners shall be (stainless steel) or (zinc coated) for corrosion resistance.

2.3 COMPONENTS

A. Framing:

1. Type: (Extruded aluminum) (Mild/Structural steel A36 and A500)
2. Size: 8" x .125"

B. Cantilever mount. 6'-0" depth.

C. Decking: 3" x 6" x .090" Interlocking Extruded aluminum flat (flush) soffit decking with openings to accommodate light fixtures.

D. Attachment; As required to meet final conditions.

E. Fascia Profiles: 8" standard "J" fascia profile with integral gutters.

F. Other Components: other components as indicated or as required for system attachment and performance.

2.4 FABRICATION

A. Fabricate canopy system in accordance with approved Shop Drawings.

B. Canopies to be pre-assembled and welded by MASA approved personnel.
Where pre-assembled canopies are too large for transport mechanical field assembly will be accepted.

2.6 FINISHES

Aluminum:

1. AAMA 2605, Two-coat Fluoropolymer coating containing minimum 70% PVDF resins.
2. Source: Duranar by PPG Industries, Inc.
3. Color: Custom color to match Architect’s sample.

PART 3 - EXECUTION

3.1 FIELD DIMENSIONS

A. Field verify dimensions of supporting structure at site of installation prior to fabrication.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Install components plumb and level, in proper plane, free from warp and twist.

C. Anchor system to building components; provide adequate clearance for movement caused by thermal expansion and contraction and wind loads.

3.3 ADJUSTING

A. Touch up minor scratches and abrasions on finished surfaces to match original finish.

B. Clean with mild, non-abrasive solution and a cotton cloth under low pressure.

END OF SECTION 107300

SECTION 111300 - MISCELLANEOUS DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the following Dock Equipment:

1. Dock Lights
2. Dock Seals
3. Dock Bumper
4. Dock Truck Restraints
5. Bollard Mounted Loading Dock Safety Barrier

B. Related Documents:

1. The Conditions of the Tender Documents apply to this Section as fully as if repeated herein.

C. The Contractor is to provide all labor, services, material, and equipment, and the performance of all work as necessary to provide all equipment as indicated on the Drawings.

D. All equipment furnished under this tender shall meet all applicable local and national codes as well as all health and sanitary codes.

E. The tender drawings, equipment and system interfaces outline the general requirements for the equipment in this section. The Contractor is responsible for engineering the final equipment layout, equipment interfaces, and all other details specified herein. In addition, the Contractor shall be responsible for the complete coordination of their layout with all other building systems and system interfaces.

1.2 SUBMITTALS

A. Before executing any work under this section of specifications, furnish submittals in accordance with the Tender Documents, SUBMITTAL PROCEDURES, to show full compliance with the contract.

1. Product Data and Manufacturer’s Literature and Data:
    a. Brochures showing name and address of manufacturer, catalog or model number of each item incorporated into the work.
    b. Manufacturer’s illustration and detailed description.
    c. List of deviations from Specifications.
2. The manufacturer shall certify that the product offered meets the characteristics of the specified description and that the product conforms to the producer’s own drawings, specifications, standards, and quality assurance practices.
3. Provide certified equipment test reports on each type of equipment to be furnished. Reports shall include, but not be limited to, scale accuracy.
    a. Tests shall be conducted by the manufacturer in the manufacturer’s own facility and shall also be conducted on the same type of equipment to be furnished on thus Project.

b. Test records need not be re-certified providing no essential change in design has been made since tests were conducted.

4. Shop Drawings: Complete and detailed for each item specially fabricated. B.

Submittal procedures and quantities are specified in the Tender Documents.

C. Show dimensions method of assembly, installation, and conditions relating to adjoining work, which requires cutting or close fitting, reinforcement, anchorage, and other work required for complete installation for equipment detailed in this Section.

D. Submittals will be reviewed for general design only, and not for method of assembly, construction, or detailed compliance with Tender Documents.

E. No deviation from Tender Documents is permitted unless specifically so noted by the General Contractor and accepted by the General Contractor in writing.

F. General Contractor Responsibility:

1. Coordination with work of other trades.
2. Space coordination.
3. Assembly and installation techniques, including structural adequacy and suitable bracing.
4. Maintenance of installation safety.
5. Satisfactory performance of all work.

1.3 QUALITY ASSURANCE

A. Qualifications Manufacturer shall regularly and currently manufacture specified equipment as one of its principal products.

B. Manufacturer shall have technical qualifications, experience, trained personnel, and facilities to install specified items.

C. Manufacturer shall have equivalent product currently installed to installation and similar to this Project that has been in satisfactory and efficient operation.

D. There shall be a permanent service organization, maintained and trained by Equipment Manufacturer/Supplier, which will render emergency service

E. Unless specified, all materials and equipment to be permanently installed shall be new and of such quality to satisfy the standards of the Documents.

F. Workers skilled in their respective trades shall perform all labor; workmanship shall be of good quality so that first-class work is performed in accordance with the standards of construction.

G. The Contractor is solely responsible for the accurate installation of equipment / systems and shall correct any operational aspects and deficiencies.

H. If the Contractor performs any work which is contrary to any laws, ordinances, Codes, rules and regulations, the Contractor will make all necessary changes as required to comply therewith and bear all costs.

I. All parts of equipment shall be of design, size and material to satisfactorily function under all conditions within rated load and speed range.

J. All parts shall be built to definite standard dimensions and tolerances so that it will be possible to replace and/or adjust.

K. Mechanical fastenings used on parts subject to wear and replacement shall be key and seat, nut, screw, or other removable and replaceable types, which do not require physical deformation or field positioning.

1.4 MANUALS, DIAGRAMS, AND INSTRUCTIONS

A. Operating and maintenance manuals, including written instructions relative to the care, adjustment, and operation of the complete equipment together with photographs, equipment data and repair parts with numbers listed.

B. Legible schematic and field diagrams showing all electrical circuits shall be furnished. All symbols shall be listed, corresponding to the identification on the equipment furnished.

C. These items, except for final field diagrams shall be submitted with the shop drawings.

1.5 GUARANTEE

A. The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Tender Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under the requirements of the Tender Documents.

B. The equipment furnished is to be guaranteed from the date of acceptance and beneficial use or as detailed on the Documents.

C. All labor and materials furnished in connection with the installation of Equipment shall be subject to terms of “WARRANTY” articles of Section 01740, WARRANTIES AND GUARANTEES.

D. No device shall be acceptable that will not give satisfactory performance without excessive maintenance and attention. The period of guarantee shall start anew from the date of completion of each new installation performed in accordance with the preceding requirements.

1.6 EQUIPMENT MAINTENANCE

A. A Maintenance Training Program shall be provided to the Owner, at the Equipment Manufacturer's factory for training of additional Hospital technicians.

B. One month before the equipment guarantee is to expire; the Equipment Manufacturer/Supplier shall provide a review of the maintenance instruction program along with a review of the detailed parts list, individual replacement costs, descriptions and designations.

1.7 CONSTRUCTION CONDITIONS

C. Provide all necessary anchor bolts, shims, fastenings, recesses, cutouts, slots, holes, patching and the like to perform installation of equipment to code and regulations.

A. Coordinate installation with other trades.

1.8 ELECTRICAL EQUIPMENT

A. Electrical equipment shall be suitable for use with electrical system shown on the Drawings.

B. Provide all electrical wiring, conduit, and all electrical devices necessary for the installation and operation of systems and equipment furnished.

1.9 PROJECT CONDITIONS

A. Equipment Manufacturer/Supplier must review Tender Documents for compatibility with its product prior to bidding.

1. Review structural, architectural, electrical, mechanical, and plumbing drawings, and specifications.
2. Compliance with all provisions of the Tender Documents is assumed in the absence of written and approved exceptions.
3. The design of the structural, mechanical, and plumbing systems within the Project are fixed. The Equipment Manufacturer's equipment shall fit and operate within these fixed elements.

PART 2 - PRODUCTS

2.1 DOCK LIGHT

A. Products

1. Pentalift LED Dock Lights;
2. Or equivalent

B. Design Features

1. Dock light shall be mounted under the roof over-hang in the locations shown on the Project Drawings.
2. Dock light shall have a swivel-mounting bracket.
3. Light head shall fully support the enclosed lamp and be equipped with an integrated power switch.

C. Fabrication of Dock Light

1. Wiring: Three (3) -conductor cord.
2. Fixture: Shall be an incandescent / halogen PAR type.
    a. Be rated at 300 Watts, minimum.
3. Light Head: Housing shall be manufactured of steel.
    a. Shall have a safety yellow protective powder coating.
4. Wire lamp guard shall provide protection against lamp damage.
    a. Be hinged to facilitate ease of lamp replacement, using simple hand tools.

2.2 DOCK SEALS

A. Products

1. Rite-Hite FDS Series Foam Dock Seal
2. Or equivalent

B. Design Features

1. Dock Seal shall be sized by manufacturer to meet specific application requirements.
2. Beveled side pads shall provide a tight seal between the back of the trailer and the building wall.
3. Bottom of side pads shall have slit breathers.
4. Side pads shall be mounted on construction grade lumber.
5. Dock seal polyurethane foam shall be glued to wood backer.
6. Fabric shall be wrapped & attached to back of wood backer.
7. Dock seal shall have a stationary head pad.
8. Bottom of head pad shall have slit breathers.
9. Head pad shall be mounted on construction grade lumber.
10. Dock seal shall have overlapping wear pleats on ends of head pad face.

2.3 LOADING DOCK BUMPERS

A. Products

1. Durable Corp. Laminated Dock Bumper, Model # B4512-14;
2. Or equivalent

B. Design Features

1. Bumpers: Durable Laminated Rubber Dock Bumper; Fabric reinforced rubber pads laminated between structural steel angles and secured with 3/4 inch (19 mm) steel supporting rods.
    a. Projection from Wall: 114 mm
    b. Vertical Height: 305 mm; 102 mm bolt-hole centers
    c. Length: 356 mm

C. Installation

1. Install in accordance with manufacturer’s instructions.
2. Position bumpers spaced as indicated on drawings.
3. Secure angle end frames to dock face.

2.4 TRUCK RESTRAINT

A. Products

1. Provide one of the following acceptable products or approved equal product.

2. Design similar to:
    a. Rite Hite RHR-600 DOK-LOK
    b. Or equivalent

B. Design Features
1. Unit shall be designed to secure a semi-trailer to the Loading Dock by engaging the trailer ICC bumper with a large rotating hook.
2. A spring-loaded, structural steel housing shall automatically position the unit when contact is made by a backing truck.
3. The hook mechanism shall be controlled by an electric push-button station mounted onto the building.

C. Operation
1. As trailer backs into position, the ICC bumper shall contact the spring-loaded structural steel housing.
2. The housing shall ride down in its vertical channel, allowing the ICC bumper to move over the top of the housing.

D. Construction
1. Housing shall be fully enclosed, constructed of welded structural steel, designed to withstand impact from backing trailers.
2. Housing shall protect all components from damage by weather, dirt and debris. Mounting plate and rails shall be galvanized.

E. Installation
1. Truck Restraint shall be mounted above ground on a steel plate that is embedded in the dock face by anchor bolts plus welded to the dock curb angle.
2. Installation of Dock Restraint shall not require any modification to the Dock Leveler.

F. Electrical
1. All operator controls shall be mounted in a gasketed control panel.
2. The control panel shall be fully operational at all times, not requiring key turn-on, but contains solid state components.

2.5 BOLLARD MOUNTED LOADING DOCK SAFETY BARRIER

A. Design Description:
1. A bollard mounted loading dock safety net is a net that is mounted near the edge of a loading dock door to prevent materials and forklifts from falling off the edge. Bollards are often made of steel or cement and are used to protect dock door openings and other areas throughout a workplace. Bollard mounted loading dock safety nets can be wall mounted or bollard mounted and meet OSHA 1910.28 fall protection requirements.

B. Products
1. Provide one of the following acceptable products or approved equal product.

a. Rite-Hite Dok Guardian HD
b. Akon model SB-3000
c. Or equivalent

C. Design Features:
1. Curtain Height – 35.5” to 48”
2. Stopping Power – min. 13,500 lbs.
3. Deflection on Impact – 10” to 35”
4. All components must be designed/installed in accordance to the OSHA 1910.23 Protection requirement.

PART 3 - EXECUTION

3.1 MANUFACTURED PRODUCTS

A. Materials, fixtures, and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items.

B. Units shall be products of one manufacturer.

C. Manufacturer of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled units.

D. Components of an assembled unit need not be products of same manufacturer.

E. Constituent parts, which are alike, shall be the products of a single manufacturer.

F. Components shall be compatible with each other and with the total assembly for the intended service.

G. Nameplate:
1. Each piece of equipment shall bear a corrosion-resisting steel.
2. Nameplate shall be proportionate to size of equipment and bear the following:
a. Name of manufacturer.
b. Model number
c. Serial number
d. Electrical characteristics

H. Fasteners:
1. Rivets, bolts, nuts, studs, spacers, and metal used for welding shall be same kind of metal as materials joined.
2. Where corrosion-resisting metals are joined to each other, or to other metals, rivets, bolts, and materials used for welding shall be corrosion-resisting metal.

I. Welding:
1. Joints in fabricated equipment shall be welded by an accepted method.
2. Welds shall be strong and ductile, with exposed surfaces free of imperfections such as pits, runs, spatter, and cracks, and shall have same color as adjoining surfaces.

J. Steel Fabrication:

1. Steel shall be free from kinks and sharp bends.
2. All joints, openings, and doors shall be square and neat.
3. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be continuous for all major joints and shall have the strength required to satisfy the design, use, and loading conditions. All outside corners of the containment body shall be of butt joint construction.
4. Castings shall be sound and free from patching, misplaced coring, warping, or other defects, which might render the casting unsound for use.

3.2 EXAMINATION

A. Examine surfaces to receive product before application to ensure that the following conditions are met:

1. Before shipment from manufacturer's plant and following installation at project site, finished articles stating equipment has been thoroughly inspected and tested.
2. Equipment Manufacturer/Supplier shall inspect the site and conditions for which the equipment is to be installed.
3. Do not start the work of this section until all deficiencies have been corrected.

3.3 PREPARATION

A. Protect equipment against dirt, water, and chemicals during installation.

3.4 INSTALLATION

A. The work under this Section of the Specification shall include all labor, services, materials and equipment and the performance of all work as necessary and required to furnish and install the equipment.

B. Delivery and installation of the equipment shall be so performed as to avoid delay on the work by other contractors. The Contractor shall be responsible for receiving, uncrating, setting in place all of the equipment, and providing all the proper utilities under the supervision of the Equipment Manufacturer/Supplier.

C. The Equipment Manufacturer/Supplier shall be responsible for all final connections of their equipment.

D. The equipment locations, as shown on the Drawings shall be checked by the Contractor and the Equipment Manufacturer/Supplier. The Contractor shall be solely responsible for the accurate installation and correct any operational aspects and deficiencies of his equipment.

E. The Contractor and the Equipment Manufacturer/Supplier shall consult the architectural and structural drawings for all dimensions, locations of partitions, locations of pipes and ductwork.

F. The Contractor and the Equipment Manufacturer/Supplier shall have a factory trained, field service technician on the premises to supervise the installation of all equipment.

3.5 WORK BY OTHER TRADES

A. The plumbing, heating, electrical and/or air handling contractors shall, within their specific areas of responsibilities, provide all labor, services, and materials required to complete the following work:

1. Electric power wiring services to motors and control panels, which will be provided by the Contractor, will be as shown on the electrical working drawings or approved equipment shop drawings. All other wiring not shown on these drawings shall be provided by the Equipment Manufacturer/Supplier.

2. Provide final mechanical and electrical connection to all equipment herein specified.

3.6 TESTS BY EQUIPMENT MANUFACTURER/SUPPLIER

A. Equipment Manufacturer/Supplier shall perform tests under operating conditions in the presence of the Owner.

B. Provide all equipment, instruments, and labor required for tests.

C. Evidence of malfunction in any tested system, piece of equipment, or component part thereof that occurs during, or as a result of tests, shall be corrected, repaired or replaced, and the test repeated.

3.7 OPERATING AND MAINTENANCE / REPAIR TRAINING BY EQUIPMENT MANUFACTURER/SUPPLIER

A. An orientation and continuing education program shall be presented to the Owner’s employees when the equipment is operational. The program is to be presented by a fulltime employee of the Equipment Manufacturer/Supplier, trained in the respective department functions.

B. A factory-trained representative shall provide equipment demonstrations to all of the appropriate employees, including proper daily and emergency equipment operational instructions with daily start-up and shutdown procedures.

1. To accommodate employees on all shifts, the Equipment Manufacturer/Supplier shall provide a minimum of two (2) days of education / orientation to all appropriate employees.

2. The Equipment Manufacturer/Supplier shall provide the Owner with an hourly rate for any educational programs beyond the specified time.

C. An instruction program shall be provided to the Owner's maintenance personnel, by fully trained and full-time instructors, on the maintenance, care, adjustment and operation of the Equipment as detailed above.

1. To accommodate employees on all shifts, the Equipment Manufacturer/Supplier shall provide a minimum of two (2) days of education / orientation for the Owner's maintenance personnel on all equipment specified in this Section.

2. The Equipment Manufacturer/Supplier shall provide the Owner with an hourly rate for any educational programs beyond the specified time.

D. All instruction shall include classroom hands-on training when the equipment is in operation, but before the Owner begins beneficial use. Training to consist of a minimum of 8-hours instruction and the Equipment Manufacturer/Supplier needs to provide the training schedule to the Owner.

3.8 EMERGENCY SERVICE

A. During the duration of the warranty, the Equipment Manufacturer/Supplier shall provide emergency service within four (4) hours of notification of trouble and return to operation any piece of equipment within twenty-four (24) hours of reported failure.

END OF SECTION 111300

SECTION 111310 - HYDRAULIC DOCK LEVELER

PART 1 – GENERAL

1.1 SUMMARY

A. This section covers the following Dock Equipment:
   1. Hydraulic Dock Leveler
   2. Dock Leveler Control

B. Related Documents:
   1. The Conditions of the Contract and DIVISION 1 apply to this Section as fully as if repeated herein.

C. The General Contractor is to provide all labor, services material, and equipment, and the performance of all work as necessary to provide all equipment as indicated on the Drawings, and as specified herein.

D. All equipment furnished under this contract shall meet all applicable local and national Codes, as well as all health and sanitary Codes.

E. The contract drawings, equipment and system interfaces outline the general requirements for the equipment specified in this section. The Equipment Manufacturer is responsible for engineering the final equipment layout, interfaces, and all other details specified herein. In addition, the Equipment Manufacturer shall be responsible for coordination of this layout with all other building systems and system interfaces.

1.2 REFERENCES

A. Electrical power, wiring and connections: DIVISION 16 – ELECTRICAL.

1.3 SUBMITTALS

A. Before executing any work under this section of specifications, furnish submittals in accordance with SUBMITTAL PROCEDURES, to show full compliance with contract requirements on items proposed to be furnished.
   1. Product Data and Manufacturer's Literature and Data:
      a. Brochures showing name and address of manufacturer, catalog or model number of each item incorporated into the work.
      b. Manufacturer's illustration and detailed description.
      c. List of deviations from Specifications.

   2. Certificates: The manufacturer shall certify that the product offered meets the characteristics of the specified description and that the product conforms to the producer's own drawings, specifications, standards, and quality assurance practices.
   3. Test Reports: Provide certified equipment test reports on each type of equipment to be furnished. Reports shall include, but not be limited to, scale accuracy.
      a. Tests shall be conducted by the manufacturer in the manufacturer's own facility and shall also be conducted on the same type of equipment to be furnished on this Project.

b. Test records need not be re-certified providing no essential change in design has been made since tests were conducted.

4. Shop Drawings: Complete and detailed for each item specially fabricated.

B. Closeout Submittals: Submittal procedures and quantities are specified in Section 01 77 00.

C. Installation Drawings: Show dimensions method of assembly, installation, and conditions relating to adjoining work which requires cutting or close fitting, reinforcement, anchorage, and other work required for complete installation for equipment detailed in this Section.

D. Review: Submittals will be reviewed for general design only, and not for method of assembly, construction, or detailed compliance with Contract Documents. One (1) major and one (1) minor review shall be performed. All additional submittal reviews shall be performed on an hourly basis (using reviewer's most current published rates) and billed to the Equipment Manufacturer.

E. No deviation from Contract Documents is permitted unless specifically so noted by the General Contractor and accepted by the General Contractor in writing.

F. General Contractor Responsibility:
1. Errors or omissions in submittals regardless of review status of submittals
2 Coordination with work of other trades.
3. Space coordination and code compliance.
4. Assembly and installation techniques, including structural adequacy and suitable bracing and / or anchoring for stability and seismic conditions.
5. Maintenance of installation safety.
6. Satisfactory performance of all work.

1.4 QUALITY ASSURANCE

A. Qualifications: Manufacturer shall regularly and currently manufacture specified equipment as one of its principal products.

B. Manufacturer shall have technical qualifications, experience, trained personnel, and facilities to install specified items.

C. Manufacturer shall have equivalent product currently installed at three (3) installations similar to this Project that has been in satisfactory and efficient operation for three (3) years.

D. There shall be a permanent service organization, maintained and trained by Equipment Manufacturer, which will render emergency service within four (4) hours of notification that service is needed.

E. All materials and equipment to be permanently installed shall be new and of such quality to satisfy the standards of the Documents. The Equipment Manufacturer, if required, shall furnish satisfactory evidence as to the kind and quality of all materials and equipment used.

F. Workers skilled in their respective trades shall perform all labor; workmanship shall be of good quality so that first-class work is performed in accordance with the standards of construction set for6th in the Documents.

G. The General Contractor and the Equipment Manufacturer are solely responsible for the accurate installation of equipment / systems and are to correct any operational aspects and deficiencies without recourse to the Owner.

H. If the Contactor performs any work which is contrary to any laws, ordinances, Codes, rules and regulations, the General Contractor will make all necessary changes as required to comply therewith and bear all costs arising there from without additional cost to the Owner.

I. All parts of equipment shall be of design, size and materials to satisfactorily function under all conditions within rated load and speed range; all with proper factors of safety, maximum and electrical efficiency and minimum wear on parts.

J. All parts shall be built to definite standard dimensions and tolerances so that it will be possible to replace and / or adjust any part without tooling or machining being required to install replacement parts.

K. Mechanical fastenings used on parts to wear and replacement shall be key and seat, nut screw, or other removable and replaceable types, which do not require physical deformation or field positioning. Rivets or similar devices are not permitted as mechanical fastenings for such parts.

1.5 MANUALS, DIAGRAMS AND INSTRUCTIONS

A. Three (3) copies of operating and maintenance manuals, including written instructions relative to the care, adjustment and operation of the complete equipment together with photographs, equipment data and repair parts with numbers listed. This shall be furnished and delivered to the Owner.

B. Three (3) sets of complete, legible schematic and field diagrams showing all electrical circuits shall be furnished. All symbols shall be listed, corresponding to the identification on the equipment furnished. Each set shall be neatly bound and delivered to the Owner.

C. These items, except for final field diagrams, shall be submitted with the shop drawings.

1.6 GUARANTEE

A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the General Contractor under the requirements of the Contract Documents.

B. Special Warranty: The equipment furnished is to be guaranteed for three (3) full years, from the date of acceptance and beneficial use or as detailed on the

Documents. This guarantee is to include all replacement parts, as necessary to keep the equipment operational in accordance with the performance specifications and to the Owner's satisfaction.

C. All labor and materials furnished in connection with the installation of equipment shall be subject to terms of “WARRANTY” articles of Section 00 70 00, GENERAL CONDITIONS. Upon receipt of notice from the Owner of failure of any portion of materials and workmanship furnished, the General Contractor shall promptly replace the affected part(s) with new part(s) at his own expense.

D. No device shall be acceptable that will not give satisfactory performance without excessive maintenance and attention. If it becomes evident during the guarantee period that the device is not functioning properly or in accordance with the Contract requirements, or if in the opinion of the Owner, excessive maintenance and attention must be employed to keep such device operating, the device must be removed. A new device meeting all requirements shall be installed as part of contractual work until satisfactory operation of installation is obtained. The period of guarantee shall start anew from the date of completion of each new installation performed in accordance with the preceding requirements.

1.7 EQUIPMENT MAINTENANCE

A. The Owner shall be provided with a formal Preventive Maintenance Contract with a detailed parts list, replacement costs, descriptions and designations. The Preventive Maintenance Contract, if accepted by the Owner, is not to go into effect until after the guarantee expires. The Owner has the option to accept or decline the Preventive Maintenance Contract.

B. A Maintenance Training Program shall be provided to the Owner, at the Equipment Manufacturer's factory, for training of additional Hospital technicians. Costs for this program shall be at the standard rate for this service.

C. One month before the equipment guarantee is to expire; the Equipment Manufacturer shall provide a review of the maintenance instruction program along with a review of the Preventive Maintenance Contract with its detailed parts list, individual replacement costs, descriptions and designations.

1.8 TOOLS

A. Provide one (1) complete set of special tools necessary to maintain and make adjustments on every part of the equipment, if such tools are required for the maintenance of the equipment.

1.9 CONSTRUCTION CONDITIONS

A. Provide all necessary anchor bolts, shims, fastenings, recesses, cutouts, slots, holes, patching and the like to perform installation of equipment to code and regulations.

B. Coordinate installation with other trades. Provide and obtain dimensions, clearances and similar data.

1.10 ELECTRICAL EQUIPMENT

A. Electrical equipment shall be suitable for use with electrical system shown on the Drawings.

B. Provide electrical components including motors, disconnect switches, motor controllers, motor control devices, and electrical circuits and connections which conform to requirements of NFPA 70 whether or not electrical components are furnished as part of equipment assemblies.

C. Provide all electrical wiring, conduit, and all electrical devices necessary for the installation and operation of systems and equipment furnished.

1.11 PROJECT CONDITIONS

A. In order to discover and resolve conflicts or lack of definition, which might create problems, the Equipment Manufacturer must review contract documents for compatibility with its product prior to bidding.
   1. Review structural, architectural, electrical, mechanical and plumbing drawings, and specifications.
   2. Compliance with all provisions of the contract documents is assumed in the absence of written and approved exceptions.
   3. The design of the structural, mechanical, and plumbing systems within the Project are fixed. The Equipment Manufacturer's equipment shall fit and operate within these fixed elements.

PART 2 – PRODUCTS

2.1 HYDRAULIC DOCK LEVELER

A. Manufacturers. Provide one of the following acceptable products or approved equal product.
   1. Design similar to:
      a. Manufactures: Kelly Atlantic HK Series;
      b. Blue Giant Hydraulic Dock Leveler; or equal.

B. Design Features:
   1. Hydraulic Dock Leveler shall be supplied assembled and ready for use. Unit shall be fully mechanical with no manual lifting required to operate.

   2. Platform Load Capacity:
      a. Moving or rollover load of 11,340 kg (25,000 lbs) when the front edge of the lip is resting on the floor or bed of a motor truck without permanent deflection or distortion.

      b. Gross load of 11,340 kg (25,000 lbs) when the platform is not engaging the floor bed of a motor truck.

   3. Platform Size:
      a. Approximately 1.83 m (6 feet) wide by 2.44 m (8 feet) long (nominal).

b. Include a minimum lip length of 406.4 mm (16 inches).

4. Flexible Leveler:
   a. Automatic compensation for an out-of-level vehicle condition of 101.6 mm (4 inches) maximum from side to side.

5. Vertical Adjustment:
   a. Minimum of 609.6 mm (24 inches).
   b. Travel of the front edge of the lip of the platform: 304.8 mm (12 inches) above or below the horizontal level of the stationary loading dock.

6. Fit into space and construction as shown.
   a. If deviations are required from space or pit construction shown, coordinate change showing changed conditions on submittal for dimensioned layout of leveler for installation.
   b. Obtain approval from Owner's Representative and Owner of proposed change.

7. Safety Device:
   a. In the event trailer or truck pulls away from the leveler platform, use a safety device to limit downward travel at the outer end of dock leveler.
   b. Safety device effective with a load on the platform up to 11,340 kg (25,000 lbs).

8. Dock Bumpers:
   a. Each Unit shall be supplied with one set of two (2) rubber dock bumpers.
   b. 224 mm (8.8 inches) high x 330.2 mm (13 inches) wide x 101.6 mm (4 inches) thick.
   c. Constructed of molded rubber (or similar) compressed between structural angle held in place by steel tie (or similar).
   d. Mounting: bumpers will be bolted or welded to face of dock.

C. Fabrication of Dock Leveler:
   1. Sub-frame Assembly:
      a. Fabricate frame assembly of structural steel shapes to receive operating components and platform assembly.
      b. Fabricate sub-frame to support not less than 1,814 kg (4,000 lbs.) on the hinge assembly.
      c. Weld assembly together except for mechanical components.
      d. Drill for bolted anchorage of mechanical components.

   2. Platform Assembly:
      a. Fabricate the platform section of not less than 6.1 mm (0.24 inches) thick non-skid steel floor plate.

   3. Hinges:
      a. Designed to safely withstand maximum moving or rollover load and impact load.

b. Use full length for lip plate to platform.
c. Use stainless steel hinge blots and hinge pin.

4. Remove burrs, sharp edges, or corners to prevent injury to personnel and tires.
5. Maintenance Safety Bar:
   a. Permanently mounted hinged steel strut capable of supporting platform in raised position including lip section.
   b. Provide retaining socket or device to prevent accidental release.

6. Welding shall be in accordance with AWS D1.1 and shall be continuous and ground smooth where exposed.

D. Hydraulic System
1. Consist of steel cylinder, steel plunger, oil connections, pressure relief value, fluid reservoirs, hydraulic valves, motor pump unit and accessories of size to assure against failure, provide maximum efficiency, and safety in operation.
2. Provide means to minimize leaking of any kind from the hydraulic system.
3. Cylinder and Plunger:
   a. Use seamless steel tubing.
   b. Turn and polish plunger and cylinder over contact surfaces.
   c. Provide positive stop ring to prevent from leaving cylinder.

4. Cylinder plunger mounting:
   a. Provide top and bottom mounting to unsure alignment and to eliminate any binding of the assembly, regardless of the position of the hydraulic cylinder, plunger, and leveler platform.
   b. Equip assembly with two bearings for vertical stability where bolted to platform or frame.

E. Power Unit
1. Power unit assembly; complete with electric motor operated pump, wiring, electric conduit, oil reservoir, and accessories.
2. Assemble on mounting bracket for bolting to sub-frame.
3. Direct-connect motor to hydraulic pump.

F. Hydraulic Flexible Hose:
1. Hydraulic hoses, connections, and piping capable of withstanding vibration and full motor pump pressure without leaking or failing.
2. Use fabric-reinforced chloroprene compound (neoprene) or other material unaffected by the hydraulic fluid.
3. Use copper alloy or cadmium plated steel hose connector.
4. Locate hose to prevent chafing or kinking and minimize bending and twisting during operation.

G. Hydraulic Fluid:
1. Hydraulic fluid shall not gum, clog, corrode the system, or injure the packing of seals.
2. Fill with sufficient fluid to operate the leveler.

H. Hydraulic System Fasteners:
1. Use key and seat, nut, screw, or other removable or replaceable types which do not require physical deformation or field positioning for mechanical fastenings used on parts subject to wear and replacement. Do not use rivets or similar devices as mechanical fastenings for such parts.
2. Bolts: fed spec. FF-B-588 or ASTM A307
3. Bolts, nuts, screws and washers coated with zinc or cadmium or made of corrosion resistant metal.

I. Electrical Requirements
1. In accordance with applicable portions of NEC (NEPA 70), NEMA ICS-1 and Electrical Section of Division 16.
2. Wire: Fed Spec. J-C-30 approved by Underwriter's Laboratories, Inc.
3. Motor and starter: 1 hp motor shall operate on 46~~8~~0 volts at the voltage supplied, wound for 3 phase, 60 cycle alternating current service. Use totally enclosed motor equipped with sealed or shielded, lubricated ball bearing.

J. Operating Station
1. Use wall mounted NEMA Type 4 enclosure for control station box.
2. Operating buttons: Provide "UP" and "Emergency Stop" buttons in a single box.
3. Recess buttons in control box or protect button by a projection peripheral collar.
4. Indelibly identify, push-button by means of cast or etched letters on the station.
5. Use constant pressure type buttons.

K. Install permanent tag or plate on each device to clearly indicate electrical characteristics and functions, as function, as necessary, to easily identify device from description of sequence of operation, and wiring diagrams required under "Shop Drawings and Manufacturer's Data".

L. Operation
1. Activation of the solenoids, motor and hydraulic pump through constant pressure on push button to raise of lower leveler platform.
2. Continuously operating pump while the platform is being positioned, except the down travel may be by gravity.

3. When "UP" push-button is depressed platform raised distance required to receive a vehicle, as soon as pressure is removed from the push-button, the lip extends, and platform lowers unless emergency stop button is depressed.
4. Emergency Stop Button: Motion of platform including lip to stop and remain in place without constant pressure. Release of emergency stop button allows leveler to operate.

M. Corrosion Protection and Painting
1. Ferrous metal surfaces including zinc coated ferrous and inaccessible ferrous surfaces (but not bearings, gear contact surfaces, part protected by lubrication, not usually painted or coated):
a. Clean, phosphate treat, and give two shop coats of rust inhibitive

paint.

b. Give two finished coats of manufacturer's standard coatings; allow coating to dry hard before shipment.

2. Separate by electrolytically inactive material dissimilar metals subject to electrolysis upon contact.

3. Protect nonferrous parts against corrosion.

2.2 HYDRAULIC DOCK LEVELER CONTROL

A. Manufacturers. Provide one of the following acceptable products or approved equal product.

1. Design similar to:

a. Kelly Atlantic HK Series;

b. Blue Giant Hydraulic Dock Leveler; or equal.

B. Design Features:

1. General: Provide Single panel to accommodate electronic function of all dock levelers. A dedicated button shall be provided for each of the Dock Leveler listed. Master control panel to be 100% UL and CSA approved (not just components).

2. Control panel to be NEMA 12, automatic motor starter, thermal overload, 2-amp control breaker with reset capability. All components to be individually circuit protected. S.A. and/or U.L. approved. The “Stop” button shall cease all dock devices when depressed and shall not require continuous pressure.

3. ~~208~~ 480-volt, 3 phase motor

PART 3 – EXECUTION

3.1 MANUFACTURED PRODUCTS

A. Materials, fixtures, and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items.

B. Units shall be products of one manufacturer.

C. Manufacturer of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled units.

D. Components of an assembled unit need not be products of same manufacturer.

E. Constituent parts, which are alike, shall be the products of a single manufacturer.

F. Components shall be compatible with each other and with the total assembly for the intended service.

G. Nameplate:

1. Each piece of equipment shall bear a corrosion-resisting steel, or deep-etched anodized aluminum nameplate located in a reasonably accessible position, permanently secured.
2. Nameplate shall be proportionate to size of equipment and bear the following:
   a. Name of manufacturer.
   b. Model number.
   c. Serial number.
   d. Electrical characteristics.

H. Fasteners:

1. Rivets, bolts, nuts, studs, spacers, and metal used for welding shall be same kind of metal as materials joined.
2. Where corrosion-resisting metals are joined to each other, or to other metals, rivets, bolts, and materials used for welding shall be corrosion-resisting metal.

I. Welding:

1. Joints in fabricated equipment shall be welded by an accepted method. Carbon arc welding is not acceptable, nor is any process permitting the pick-up of carbon acceptable.
2. Welds shall be strong and ductile, with exposed surfaces free of imperfections such as pits, runs, spatter, and cracks, and shall have same color as adjoining surfaces.

J. Steel Fabrication:

1. Steel shall be free from kinks and sharp bends. Shearing and shipping shall be done neatly and accurately. Flame cutting may be employed instead of shearing or sawing. Re-entrant cuts shall be made in the best possible manner. Burned surfaces or flame cut materials shall be ground or machined to remove ash and checks.
2. All joints, openings, and doors shall be square and neat. The finished equipment shall be free from sharp edges, fins, burrs, and sharp projections.
3. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be continuous for all major joints, and shall have the strength required to satisfy the design, use, and loading conditions. Intermittent welds may be used for attaching reinforcement members provided such welds will satisfy the design. Members to be welded shall be positioned and held by jigs or fixtures when necessary to insure accurate alignment. All outside corners of the containment body shall be of butt joint construction.
4. Castings shall be sound and free from patching, misplaced coring, warping, or other defects, which might render the casting unsound for use. Forging shall be uniform in quality and condition, and shall be free from tears, cracks, seams, laps, internal ruptures, imbedded scale, segregation or other defects, which may detrimentally affect the suitability for the purpose intended.

3.2 EXAMINATION

A. Examine surfaces to receive product before application to ensure that the following conditions are met:
   1. Before shipment from manufacturer's plant and following installation at project site, finished articles shall be thoroughly inspected and tested for compliance with specifications.
   2. Equipment Manufacturer shall inspect the site and conditions for which the equipment is to be installed and advise the General Contractor and General Contractor, in writing, of any conditions detrimental to the proper installation and operation of the equipment.

B. Do not start the work of this section until all deficiencies have been corrected. Commencement of work constitutes acceptance of the surfaces.

3.3 PREPARATION

A. Protect equipment against dirt, water, and chemicals during installation. Thoroughly clean equipment at the completion of work.

3.4 INSTALLATION

A. The work under this Section of the Specification shall include all labor, services, materials and equipment and the performance of all work as necessary and required to furnish and install the equipment as indicated on the Drawings and as specified above.

B. Delivery and installation of the equipment shall be so performed as to avoid delay on the work by other contractors. The General Contractor shall be responsible for receiving, uncrating, setting in place all of the equipment, and providing all the proper utilities, under the supervision of the Equipment Manufacturers.

C. The Equipment Manufacturer shall be responsible for all final connections of their equipment.

D. The equipment locations, as shown on the Drawings shall be checked by the General Contractor and the Equipment Manufacturers. All exact locations shall be determined by the dimensions of the equipment approved, and the layout drawing before an apparatus is installed. The General Contractor shall be solely responsible for the accurate installation and correct any operational aspects and deficiencies of his equipment without any recourse to the Owner.

E. The General Contractor and the Equipment Manufacturer shall consult the architectural and structural drawings for all dimensions, locations of partitions, locations of pipes and ductwork.

F. The General Contractor and the Equipment Manufacturer shall have a factory trained, field service technician on the premises to supervise the installation of all equipment. This service shall be at no additional cost to the Owner.

3.5 WORK BY OTHER TRADES

A. The electrical contractors shall, within their specific areas of responsibilities, provide all labor, services, and materials required to complete the following work:
   1. Electric power wiring services to motors and control panels, which will be provided by the General Contractor, will be as shown on the electrical working drawings or approved equipment shop drawings. All other wiring not shown on these drawings shall be provided by the Equipment Manufacturer.
   2. Provide final mechanical and electrical connection to all equipment herein specified.

B All labor and materials furnished in connection with the installation shall meet all applicable local, state and Federal Codes, including OSHA, and shall be subject to terms of "General Conditions".

3.6 TESTS BY EQUIPMENT MANUFACTURER

A. Equipment Manufacturer shall perform tests under operating conditions in presence of the Owner.

B. Provide all equipment, instruments, and labor required for tests.

C. Evidence of malfunction in any tested system, piece of equipment, or component part thereof that occurs during, or as a result of tests, shall be corrected, repaired or replaced, and the test repeated.

3.7 OPERATING AND MAINTENANCE / REPAIR TRAINING BY EQUIPMENT MANUFACTURER

A. An orientation and continuing education program shall be presented to the Country employees when the equipment is operational. The program is to be presented by a full-time employee of the Equipment Manufacturer, trained in the respective department functions. The program is to be based on the department operations and employee responsibilities with audio-visual aid equipment and tape programs including operating manuals. The audio-visual programs shall be provided to the Owner at no cost for future use.

B. A factory trained representative shall provide equipment demonstration to all of the appropriate employees, including proper daily and emergency equipment operational instructions with daily start-up and shutdown procedures. Owner shall determine schedule and number of meetings to provide to all staff.

C. An instruction program shall be provided to the Owner's maintenance personnel, by fully trained and full-time instructors, on the maintenance, care, adjustment and operation of the Equipment as detailed above.

D. All instruction shall include classroom and "hands on" training when the equipment is in operation, but before the Owner begins beneficial use. The program is to include a review of equipment operation and characteristics, maintenance manuals, schematics and spare part recommendations.

3.8 EMERGENCY SERVICE

A. During the duration of the warranty, the Equipment Manufacturer must provide emergency service within four (4) hours of notification of trouble and return to operation any piece of equipment within twenty-four (24) hours of reported failure. This service is to be performed by the Equipment Manufacturer at no additional cost to the Owner.

END OF SECTION 111310

SECTION 112424 – FALL PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: This Section specifies design, supply and installation of Fall Protection systems.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC).

1. AISC S342L 1993, Load and Resistance Factor Design Specification for Structural Steel Buildings (including Supplement No.1).

B. Aluminum Association (AA).

1. AA DAF 45, Designation System for Aluminum Finishes.
2. AA ADM-1 2000, Aluminum Design Manual.

D. American Society of Mechanical Engineers (AMSE).

1. ASME A120.1 2006, Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance.

E. American National Standards Institute / International Window Cleaning Association (ANSI/IWCA).

1. ANSI/IWCA I-14.1 2006, Window Cleaning Safety Standard.

F. American Welding Society (AWS).

1. AWS D1.2/D1.2M 2003, Structural Welding Code - Aluminum.
2. AWS D1.1/D1.1M 2006, Structural Welding Code—Steel.

G. ASTM International (ASTM).

1. ASTM A123/A123M 2002, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A167 1999 (2004), Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip.
3. ASTM A276 2006, Standard Specification for Stainless Steel Bars and Shapes.
4. ASTM A492 1995 (2004) Standard Specification for Stainless Steel Rope.
5. ASTM B221 2006, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

H. International Code Council (ICC).

1. International Building Code.

I. Occupational Safety and Health Administration (OSHA).

1. OSHA 1910, Subpart D, Walking and Work Surfaces.
2. OSHA 1910, Subpart F, Appendix C, Personal Fall Arrest Systems.
3. OSHA Ruling on Window Cleaning by Bosun’s Chair.

4. OSHA 1910.66 Subpart F, Powered Platforms.

1.03 ACTION SUBMITTALS

A. Shop Drawings: Project specific. Indicate information on shop drawings as follows:

1. Submit shop drawings showing complete layout and configuration of fall protection equipment including components and accessories.
2. Indicate design and fabrication details, hardware, and installation details.
3. Include installation and rigging instructions and:

    a. Required restrictive working usage and general safety notes.
    b. Non-restrictive working usage and general safety notes.

4. Ensure Shop Drawings are reviewed by Engineer licensed in State of Kentucky and submit calculations and test reports to Architect.

B. Submit product data, including manufacturer’s technical data sheet, for specified products.

1.04 INFORMATION SUBMITTALS

A. Quality Assurance:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
2. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
3. Manufacturer’s installation instructions.

B. Manufacturer’s field reports specified.

1.05 CLOSEOUT SUBMITTALS

A. Submit 1-year standard manufacturer warranty documents specified.

B. Operation and Maintenance Data: Submit Operation and Maintenance data for installed products.
1. Include:

    a. Manufacturer’s instructions covering maintenance requirements and parts catalog giving complete list of repair and replacement parts with cuts and identifying numbers.
    b. 1 copy of system Equipment Manual & Inspection Log Book, with "Initial Inspection - Certification for Use" and "Inspection Sign-Off" forms completed.
    c. 2 copies of reduced, “as-built shop drawing” showing equipment locations and details. Ensure drawing is posted adjacent exits to roof.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

B. Regulatory Requirements.

1. Comply with International Building Code (IBC) and Building Code for State of Kentucky.
2. Comply with OSHA regulations as follows:

a. 1910, Subpart D, Walking and Working Surfaces.
b. Appendix C to 1910 Subpart F, Personal Fall Arrest Systems.
c. OSHA Ruling on Window Cleaning by Bosun's Chair.
d. 1910.66, Subpart F, Powered Platforms.

C. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, manufacturer’s installation instructions and manufacturer’s warranty requirements.

1.07 DELIVERY, STORAGE AND HANDLING

A. Ordering: Comply with manufacturer’s ordering instructions and lead time requirements to avoid construction delays.

B. Delivery:

1. Deliver materials in manufacturer’s original packaging with identification labels intact and in sizes to suit project.

C. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1.08 PROJECT AMBIENT CONDITIONS

A. Installation Location: Assemble and erect components only when temperatures are above 40 degrees F (4 degrees C).

1.09 SEQUENCING

A. Sequence with other Work and comply with equipment manufacturer’s written recommendations for sequencing construction operations.

1.10 WARRANTY

A. Project Warranty: Refer to Contract Conditions for additional project warranty provisions.

B. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and does not limit, other rights Owner may have under Contract Documents.

C. Warranty: Commencing on date of substantial completion set by Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Ensure manufacturer has minimum 10 years experience in manufacturing fall protection and suspended maintenance system components similar to or exceeding requirements of project.

2.02 PRODUCTS AND SYSTEMS

A. Basis-of-Design Manufacturer: Pro-Bel Group of Companies or approved equal.

2.03 DESIGN PERFORMANCE REQUIREMENTS

A. Design fall protection system to suit project requirements to AISC S342L and as indicated.

B. Locate anchorages to suit suspension equipment specified.

C. Design anchor components for cleaning and suspended maintenance equipment to ASME A120.1.

1. Ensure compatibility with industry standard equipment.
2. Anchorage and anchor components: Designed by Engineer qualified in design of window cleaning and suspended maintenance equipment and licensed in State of Kentucky.

D. Design system fall arrest safety anchors and equipment supports to AISC S342L (including supplement No.1) and ANSI/IWCA I-14.1, and as follows:

1. Comply with OSHA 1910, Subpart F, Appendix C.
2. Fall Arrest Safety Anchors:

a. Fall arresting force safety factor of 2 to 1 without permanent deformation: 1800 lbs (8.0 kN) minimum.
b. Fall arrest force against fracture or detachment: 5,400 lbs minimum.

2.04 EQUIPMENT

A. Anchors.

B. Double Lanyard Horizontal Lifeline Systems.

2.05 ANCHORS

A. Safety U-bars: Stainless steel to ASTM A276,Type 304 with 35 Ksi (240 MPa) minimum yield strength.

1. U-bar: 0.75 inches (19 mm) minimum diameter material with 1.5 inches (38 mm) eye opening.

B. Hollow Steel Section (HSS) Piers: Mild steel, Type 300W with 50 Ksi (350 MPa) minimum yield strength, hot dipped galvanized to ASTM A123/A123M

1. Wall thickness to suit application.

C. Plate and other sections: Mild steel, Type 300W with 44 Ksi (300 MPa) minimum yield strength, hot dipped galvanized to ASTM A123/A123M

1. Wall thickness to suit application

D. Seamless Spun Aluminum Flashing (for Roof Anchors): To AA ADM-1 Type 6061-T6 alloy and to ASTM B221.

1. Deck flange flashing: conformable mastic tape and torch applied heat-shrink rubber collar flashing or detachable watertight stainless steel cap.
2. Acceptable material: Pro-Bel Group, Aluminum Deck Flange Flashing.

E. Miscellaneous Bolts, Nuts and Washers: Stainless steel to ASTM A276, Type 304 with 5 Ksi (240 MPa) minimum yield strength.

2.06 DOUBLE LANYARD HORIZONTAL LIFELINE SYSTEM

A. Stainless steel to ASTM A492, Type 316, 0.3125 inches (8 mm) minimum diameter cable, 9127 lbs (40 kN) minimum breaking strength with permanently swedged cable ends.

B. Data plate: Ensure non-corrosive data plate stating Maximum Service Capacity of cable, Manufacturer's Name, Serial No., Manufacturing Date, rated load and other pertinent information is prominently displayed at cable system entry points.

C. Tensioner: Stainless steel turnbuckle to ASTM A167, Type 316.

D. Harness: Manufacturer's standard full body harness with double shock absorber lanyard.

E. Acceptable Material: Pro-Bel Group, Double Lanyard Horizontal Lifeline System.

2.07 SOURCE QUALITY CONTROL

A. Ensure Fall Protection equipment components and materials are from single manufacturer.

PART 3 - EXECUTION

3.01 INSTALLERS

A. Provide experienced and qualified technicians to carry out erection, assembly and installation of fall protection and suspended maintenance equipment system.

B. Do steel welding to AWS D1.2/D1.2M.

C. Do aluminum welding to AWS D1.1/D1.1M.

3.02 MANUFACTURERS INSTRUCTIONS

A. Compliance: Comply with manufacturer’s written data, including product technical bulletins, product catalog installation instructions and Pro-Bel Group technical data sheets.

3.03 EXAMINATION

A. Site Verification of Conditions:

1. Verify that substrate conditions which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer’s instructions prior to installation of window washing equipment.
2. Inform Architect of unacceptable conditions immediately upon discovery.
3. Proceed with installation only after unacceptable conditions have been remedied.

3.04 PREPARATION

A. Ensure structure or substrate is adequate to support complete window washing equipment system.

B. Ensure structural steel to receive safety anchors has adequate bearing surface as indicated on shop drawings and has 100% welds between anchors and structural steel.

3.05 INSTALLATION

A. Coordinate fall protection work with work of other trades, for proper time and sequence to avoid construction delays.

B. Install fall protection equipment plumb and level in accordance with manufacturer’s written instructions.

C. Mechanically fasten anchors in accordance with manufacturer’s recommendations

D. Accurately fit and align, securely fasten and install free from distortion or defects.

E. Deform threads of tail end of anchor studs after nuts have been tightened to prevent accidental removal and vandalism.

F. Mark anchorage points with bright/fluorescent paint and identify them with weatherproof tags/labels.

3.06 FIELD QUALITY CONTROL

A. When necessary have the manufacture assist in installation.

B. Manufacturer’s Field Services: Have manufacturer’s technical representative schedule site visits to review work as follows:

1. After delivery and storage of products.
2. When preparatory work for which work of this Section depends is complete, but before installation begins.
3. 2 times during progress of work at 25% and 60% of completion.
4. Upon completion of work, after cleaning is carried out.

C. Testing: Test on site 100% of anchors relying upon chemical adhesive fasteners using load cell test apparatus in accordance with manufacturer's written recommendations.

3.07 ADJUSTMENT

A. Lubricate moving parts to operate smoothly and fit accurately.

B. Complete "Initial Inspection - Certification for Use" form included in Equipment Manual and Inspection Log Book provided by manufacturer.

3.08 FINAL CLEANING

A. Upon completion, remove surplus and excess materials, rubbish, tools and equipment.

3.09 PROTECTION

A. Make good damage to adjacent materials caused by fall protection equipment installation.

3.10 MAINTENANCE

A. Regularly and systematically examine, clean, adjust and lubricate moving parts.

B. Repair or replace parts of fall protection equipment whenever required due to defect and normal wear and tear.

C. Use only standard parts of product line of manufacturer of window washing equipment.

D. Maintain locally adequate stock of parts for replacement or emergency purposes.

E. Provide personnel to perform work under supervision and in direct employ of window washing equipment system manufacturer or manufacturer's licensed agent.

F. Perform work during regular trade working hours satisfactory to Owner.

G. Provide emergency call-back at no extra cost and ensure fulfillment of maintenance and emergency service without undue loss of time to Owner.

H. Ensure that maintenance personnel register with designated building personnel at time of inspections and maintenance.

END OF SECTION 112424

SECTION 118226 - WASTE COMPACTORS AND DESTRUCTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers Self-Contained Waste Compactor / Containers.

B. The Owner is to provide all labor, services material, and equipment, and the performance of all work as necessary to provide all equipment as indicated on the Drawings, and as specified herein.

C. All equipment furnished under this contract shall meet all applicable local and national Codes, as well as all health and sanitary Codes.

D. The contract drawings, equipment and system interfaces outline the general requirements for the equipment specified in this section. The Equipment Manufacturer is responsible for engineering the final equipment layout, interfaces, and all other details specified herein. In addition, the Equipment Manufacturer shall be responsible for coordination of this layout with all other building systems and system interfaces.

1.2 REFERENCES

A. Electrical power, wiring and connections: DIVISION 16 – ELECTRICAL.

1.3 SUBMITTALS

A. Before executing any work under this section of specifications, furnish submittals to show full compliance with contract requirements on items proposed to be furnished.

1. Product Data and Manufacturer’s Literature and Data:

a. Brochures showing name and address of manufacturer, catalog or model number of each item incorporated into the work.

b. Manufacturer’s illustration and detailed description.

c. List of deviations from Specifications.

2. Certificates: The manufacturer shall certify that the product offered meets the characteristics of the specified description and that the product conforms to the producer’s own drawings, specifications, standards, and quality assurance practices.

3. Test Reports:

a. Provide certified equipment test reports on each type of equipment to be furnished. Reports shall include, but not be limited to, scale accuracy.

b. Tests shall be conducted by the manufacturer in the manufacturer’s own facility and shall also be conducted on the same type of equipment to be furnished on thus Project.

c. Test records need not be re-certified providing no essential change in design has been made since tests were conducted.

4. Shop Drawings: Complete and detailed for each item specially fabricated.

B. Installation Drawings: Show dimensions method of assembly, installation, and conditions relating to adjoining work which requires cutting or close fitting, reinforcement, anchorage, and other work required for complete installation for equipment detailed in this Section.

C. Review: Submittals will be reviewed for general design only, and not for method of assembly, construction, or detailed compliance with Contract Documents. One (1) major and one (1) minor review shall be performed. All additional submittal reviews shall be performed on an hourly basis (using reviewer's most current published rates) and billed to the Equipment Manufacturer.

D. No deviation from Contract Documents is permitted unless specifically so noted by the Owner and accepted by the Owner in writing.

E. Owner Responsibility:

1. Errors or omissions in submittals regardless of review status of submittals
2. Coordination with work of other trades.
3. Space coordination and code compliance.
4. Assembly and installation techniques, including structural adequacy and suitable bracing and / or anchoring for stability and seismic conditions.
5. Maintenance of installation safety.
6. Satisfactory performance of all work.

1.4 QUALITY ASSURANCE

A. Qualifications: Manufacturer shall regularly and currently manufacture specified equipment as one of its principal products.

B. Manufacturer shall have technical qualifications, experience, trained personnel, and facilities to install specified items.

C. Manufacturer shall have equivalent product currently installed at three (3) installations similar to this Project that has been in satisfactory and efficient operation for three (3) years.

D. There shall be a permanent service organization, maintained and trained by Equipment Manufacturer, which will render emergency service within four (4) hours of notification that service is needed.

E. All materials and equipment to be permanently installed shall be new and of such quality to satisfy the standards of the Documents. The Equipment Manufacturer, if required, shall furnish satisfactory evidence as to the kind and quality of all materials and equipment used.

F. Workers skilled in their respective trades shall perform all labor; workmanship shall be of good quality so that first-class work is performed in accordance with the standards of construction set for6th in the Documents.

G. The Owner and the Equipment Manufacturer are solely responsible for the accurate installation of equipment / systems and are to correct any operational aspects and deficiencies without recourse to the Owner.

H. If the Contactor performs any work which is contrary to any laws, ordinances, Codes, rules and regulations, the Owner will make all necessary changes as required to comply therewith and bear all costs arising there from without additional cost to the Owner.

I. All parts of equipment shall be of design, size and materials to satisfactorily function under all conditions within rated load and speed range; all with proper factors of safety, maximum and electrical efficiency and minimum wear on parts.

J. All parts shall be built to definite standard dimensions and tolerances so that it will be possible to replace and / or adjust any part without tooling or machining being required to install replacement parts.

K. Mechanical fastenings used on parts to wear and replacement shall be key and seat, nut screw, or other removable and replaceable types, which do not require physical deformation or field positioning. Rivets or similar devices are not permitted as mechanical fastenings for such parts.

1.5 MANUALS, DIAGRAMS, AND INSTRUCTIONS

A. Three (3) copies of operating and maintenance manuals, including written instructions relative to the care, adjustment, and operation of the complete equipment together with photographs, equipment data and repair parts with numbers listed. This shall be furnished and delivered to the Owner.

B. Three (3) sets of complete, legible schematic and field diagrams showing all electrical circuits shall be furnished. All symbols shall be listed, corresponding to the identification on the equipment furnished. Each set shall be neatly bound and delivered to the Owner.

C. These items, except for final field diagrams, shall be submitted with the shop drawings.

1.6 GUARANTEE

A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Owner under the requirements of the Contract Documents.

B. Special Warranty: The equipment furnished is to be guaranteed for three (3) full years, from the date of acceptance and beneficial use or as detailed on the Documents. This guarantee is to include all replacement parts, as necessary to keep the equipment operational in accordance with the performance specifications and to the Owner's satisfaction.

C. All labor and materials furnished in connection with the installation of equipment shall be subject to terms of “WARRANTY” articles of Section 00 70 00, GENERAL CONDITIONS. Upon receipt of notice from the Owner of failure of any portion of materials and workmanship furnished, the Owner shall promptly replace the affected part(s) with new part(s) at his own expense.

D. No device shall be acceptable that will not give satisfactory performance without excessive maintenance and attention. If it becomes evident during the guarantee period that the device is not functioning properly or in accordance with the Contract requirements, or if in the opinion of the Owner, excessive maintenance and attention must be employed to keep such device operating, the device must be removed. A new device meeting all requirements shall be installed as part of contractual work until satisfactory operation of installation is obtained. The period of guarantee shall start anew from the date of completion of each new installation performed in accordance with the preceding requirements.

1.7 EQUIPMENT MAINTENANCE

A. The Owner shall be provided with a formal Preventive Maintenance Contract with a detailed parts list, replacement costs, descriptions and designations. The Preventive Maintenance Contract, if accepted by the Owner, is not to go into effect until after the guarantee expires. The Owner has the option to accept or decline the Preventive Maintenance Contract.

B. A Maintenance Training Program shall be provided to the Owner on-site, or at the Equipment Manufacturer's factory if required, for training of additional Hospital technicians. Costs for this program shall be at the standard rate for this service.

C. One month before the equipment guarantee is to expire; the Equipment Manufacturer shall provide a review of the maintenance instruction program along with a review of the Preventive Maintenance Contract with its detailed parts list, individual replacement costs, descriptions, and designations.

1.8 TOOLS

A. Provide one (1) complete set of special tools necessary to maintain and make adjustments on every part of the equipment, if such tools are required for the maintenance of the equipment.

1.9 CONSTRUCTION CONDITIONS

A. Provide all necessary anchor bolts, shims, fastenings, recesses, cutouts, slots, holes, patching and the like to perform installation of equipment to code and regulations.

B. Coordinate installation with other trades. Provide and obtain dimensions, clearances, and similar data.

1.10 ELECTRICAL EQUIPMENT

A. Electrical equipment shall be suitable for use with electrical system shown on the Drawings.

B. Provide electrical components including motors, disconnect switches, motor controllers, motor control devices, and electrical circuits and connections which conform to requirements of NFPA 70 whether or not electrical components are furnished as part of equipment assemblies.

C. Provide all electrical wiring, conduit, and all electrical devices necessary for the installation and operation of systems and equipment furnished.

1.11 PROJECT CONDITIONS

A. In order to discover and resolve conflicts or lack of definition, which might create problems, the Equipment Manufacturer must review contract documents for compatibility with its product prior to bidding.

i. Review structural, architectural, electrical, mechanical, and plumbing drawings, and specifications.

ii. Compliance with all provisions of the contract documents is assumed in the absence of written and approved exceptions.

iii. The design of the structural, mechanical, and plumbing systems within the Project are fixed. The Equipment Manufacturer’s equipment shall fit and operate within these fixed elements.

PART 2 - PRODUCTS

2.1 SELF-CONTAINED WASTE COMPACTOR / CONTAINER

A. Manufacturers. Provide the following acceptable products or approved equal product.

a. Design similar to:

1. Marathon Equipment Company (#RJ-250-SC)
2. Wastequip Corporation (#265X)
3. PTR Baler & Compactor, INC. (#PT-300); or equal

B. Design Features:

4. Container Capacity – Minimum 20 cubic yards.

C. Performance:

5. Cycle Time - Maximum 33 seconds.
6. Normal Ram Face Pressure – Normal @ 25.00 psi. Max. @ 31.73 psi.

D. Electrical Equipment:

7. Electric Motor (3 phase-208/230/460v) – Minimum 10 hp.

PART 3 - EXECUTION

3.1 MANUFACTURED PRODUCTS

A. Materials, fixtures, and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items.

B. Units shall be products of one manufacturer.

C. Manufacturer of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled units.

D. Components of an assembled unit need not be products of same manufacturer.

E. Constituent parts, which are alike, shall be the products of a single manufacturer.

F. Components shall be compatible with each other and with the total assembly for the intended service.

G. Nameplate:

i. Each piece of equipment shall bear a corrosion-resisting steel, or deep-etched anodized aluminum nameplate located in a reasonably accessible position, permanently secured.

ii. Nameplate shall be proportionate to size of equipment and bear the following:

1. Name of manufacturer.
2. Model number.
3. Serial number.
4. Electrical characteristics.

H. Fasteners:

iii. Rivets, bolts, nuts, studs, spacers, and metal used for welding shall be same kind of metal as materials joined.

iv. Where corrosion-resisting metals are joined to each other, or to other metals, rivets, bolts, and materials used for welding shall be corrosion-resisting metal.

I. Welding:

v. Joints in fabricated equipment shall be welded by an accepted method. Carbon arc welding is not acceptable, nor is any process permitting the pick-up of carbon acceptable.

vi. Welds shall be strong and ductile, with exposed surfaces free of imperfections such as pits, runs, spatter, and cracks, and shall have same color as adjoining surfaces.

J. Steel Fabrication:

vii. Steel shall be free from kinks and sharp bends. Shearing and shipping shall be done neatly and accurately. Flame cutting may be employed instead of shearing or sawing. Re-entrant cuts shall be made in the best possible manner. Burned surfaces or flame cut materials shall be ground or machined to remove ash and checks.

viii. All joints, openings, and doors shall be square and neat. The finished equipment shall be free from sharp edges, fins, burrs, and sharp projections.

ix. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be continuous for all major joints and shall have the strength required to satisfy the design, use, and loading conditions. Intermittent welds may be used for attaching reinforcement members provided such welds will satisfy the design. Members to be welded shall be positioned and held by jigs or fixtures when necessary to insure accurate alignment. All outside corners of the containment body shall be of butt joint construction.

x. Castings shall be sound and free from patching, misplaced coring, warping, or other defects, which might render the casting unsound for use. Forging shall be uniform in quality and condition, and shall be free from tears, cracks, seams, laps, internal ruptures, imbedded scale, segregation or other defects, which may detrimentally affect the suitability for the purpose intended.

3.2 EXAMINATION

A. Examine surfaces to receive product before application to ensure that the following conditions are met:

xi. Before shipment from manufacturer's plant and following installation at project site, finished articles shall be thoroughly inspected and tested for compliance with specifications.

xii. Equipment Manufacturer shall inspect the site and conditions for which the equipment is to be installed and advise the Owner and Owner, in writing, of any conditions detrimental to the proper installation and operation of the equipment.

B. Do not start the work of this section until all deficiencies have been corrected. Commencement of work constitutes acceptance of the surfaces.

3.3 PREPARATION

A. Protect equipment against dirt, water, and chemicals during installation. Thoroughly clean equipment at the completion of work.

3.4 INSTALLATION

A. The work under this Section of the Specification shall include all labor, services, materials and equipment and the performance of all work as necessary and required to furnish and install the equipment as indicated on the Drawings and as specified above.

B. Delivery and installation of the equipment shall be so performed as to avoid delay on the work by other contractors. The Owner shall be responsible for receiving, uncrating, setting in place all of the equipment, and providing all the proper utilities, under the supervision of the Equipment Manufacturers.

C. The Equipment Manufacturer shall be responsible for all final connections of their equipment.

D. The equipment locations, as shown on the Drawings shall be checked by the Owner and the Equipment Manufacturers. All exact locations shall be determined by the

dimensions of the equipment approved, and the layout drawing before an apparatus is installed. The Owner shall be solely responsible for the accurate installation and correct any operational aspects and deficiencies of his equipment without any recourse to the Owner.

E. The Owner and the Equipment Manufacturer shall consult the architectural and structural drawings for all dimensions, locations of partitions, locations of pipes and ductwork.

F. The Owner and the Equipment Manufacturer shall have a factory trained, field service technician on the premises to supervise the installation of all equipment. This service shall be at no additional cost to the Owner.

END OF SECTION 118226

SECTION 142100
ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Traction elevators as follows:
   1. Twelve (12) Geared Elevators:
      a. Three (3) Geared Passenger Elevators, Cars 1 - 3.
      b. Three (3) Geared Service Elevators, Cars 4 - 6.
      c. Two (2) Geared Passenger Elevators, Cars 7 - 8
      d. Four (4) Geared Passenger Elevators, Cars 9, 10 - 12.

B. Products Installed but Not Furnished Under This Section:
   1. CCTV camera provisions.
   2. Elevator security devices, control unit, mounting brackets, wiring materials, logic circuits, security system interface terminals, boxes and relays.
   3. Car flooring.
   4. Building Automation System - Monitoring system interface.

1.2 ALLOWANCES

A. Elevator Car Allowances:
   1. Elevator Car Allowances:
      a. Cars 1 - 3, Cars 4 - 6
         Provide finished service/staff elevators (cars 1 thru 6) cars under the elevator car allowance of $20,000 per car for the staff/service elevators
      b. Cars 7 - 8, 9 - 12
         1) Provide finished passenger/public elevator cars under the elevator car allowance of $30,000 per car (Cars 7 thru 12)
   2. Allowance includes furnishing the following:
      a. Car wall finishes material including trim.
      b. Car ceiling finishes including lighting, wiring, and coordination of battery operated emergency lighting
      c. Car light fixtures
      d. Handrails
      e. Cutouts and other provisions for installing elevator signal equipment in cars
      f. Mounting for protective pads Provide finished passenger elevators under the elevator car allowance specified in Division 01 section “Allowances.”

1.3 ALTERNATES:

A. Refer to Division 01 section “Alternates” for requirements and procedures for acceptance.
   1. Not required.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Include capacities, sizes, performances, operation, control, signal systems operations, safety features, finishes, and similar information.
   2. Include product data for car enclosures and hoistway entrances.

3. Include product data for signal fixtures, lights, graphics, Tactile marking plates, and details of mounting.

B. Shop Drawings:
1. Provide scaled shop drawings and construction drawings of the following:
   a. Plan and section layouts of hoistways, pits, overheads, machinery spaces and openings at each landing, to include the following:
      1) Location of all equipment.
      2) Static and dynamic loads imposed on building structure.
      3) Details of equipment isolation.
      4) Required clearances around equipment.
      5) Machine room heat release.
         a) Provide heat loads based on a non-regenerative emergency power operation.
      6) Power requirements:
         a) motor horsepower, code letter, starting current, full load running current, and demand factor.
      7) Service connections.
      8) Running Clearances.
      9) Location of fixtures.
   b. Elevation section of hoistways:
      1) Overhead, pits (clearance, runby, etc).
      2) Entrance details.
      3) Sill support detail.
   c. Pit Equipment:
      1) Buffers.
      2) Compensation equipment and tie-downs.
      3) Counterweight guards.
      4) Pit reactions.
      5) Service ladder, platform.
         a) Coordinate Car 7 and Car 8 extended buffer access platform.
      6) Stop switches.
   d. Elevator cabs:
      1) Car shell fabrication.
      2) Ventilation.
      3) Ceiling construction detail.
      4) Wall construction detail.
      5) Lighting detail.
      6) Handrail mounting detail.
      7) Transom, front returns.
   e. Fixtures: Individual and Coordinated Lobby Elevation at main floor, upper terminal floor, and lower terminal floor.
      1) Car operating panel.
      2) Hall stations.
      3) Hall Lanterns.
      4) Position indicators.
      5) Access key switch.
      6) Remote panel:
         a) Lobby Desk panel.
         b) Firefighter’s Control Panel.
         c) Emergency Power selector switches.
      7) Two-way conversation device (all master stations).
2. All submittals shall be clearly marked and identified with project title and appropriate device identification.

3. Confirm Elevator Identification prior to initial submittal. Include confirmed University 4-digit number with alpha character prior to submittal review
4. All submittals are subject to approval.
5. Corrections requested shall be incorporated onto the submittals.
6. All submittals shall also be submitted to Elevator Consultant via Portable Document Format (.pdf).

C. Samples for Initial Selection:
1. For finishes involving surface treatment, paint or color selection per Architectural list:
   a. Car 1 – 3 and 4 – 6 hoistway door frames, hoistway door panels, hall fixtures faceplate.
      1) RAL color to be determined by Architect.
   b. Materials included in allowance.

D. Samples for Verification:
1. For exposed car, hoistway door and frame, and signal equipment finishes.
2. Samples of sheet materials: 3" (75 mm) square.
3. Running trim members: 4" (100 mm) lengths.

1.5 CLOSEOUT SUBMITTALS

A. Continuing Maintenance Proposal:
1. If directed by UK Purchasing, submit a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth therein, and in same form as, “Owner’s Elevator Maintenance Agreement” at end of this Section, starting on date warranty maintenance service is completed.

B. Record Documents
1. The following record documents shall be furnished upon completion and before final payment:
   a. Shop Drawings:
      1) Complete sets of as installed plan and section layouts of hoistways, pits, overheads and machinery spaces, to include the following:
         a) Static and dynamic loads imposed on building structure.
         b) Details of equipment isolation.
         c) Required clearances around equipment.
         d) Machine room heat release/diversity factor.
         e) Power requirements.
      2) Elevation section of hoistways:
         a) Overhead, pits and entrance details.
      3) Elevator cabs.
      4) Fixtures:
         a) Car fixtures.
         b) Hall fixtures.
         c) Remote fixtures.
      5) Machine room heat release/diversity factor and power requirements.
   b. Wiring Diagrams:
      1) Complete sets of as installed straight-line wiring diagrams, showing the electrical connections of all altered vertical transportation equipment, shall be furnished upon completion.
      2) A legend sheet shall be furnished with each set of drawings containing the following information:
         a) Name and symbol of each relay, switch and other electrical or solid-state apparatus.

b) Location on drawings, drawing sheets, number and area of switches and relays, etc., and location of all contacts.
c) Location of apparatus whether on controller, hoistway or elevator cab.

c. Maintenance and Operating Manuals:
1) Description and sequence of operation of all equipment installed, including operating use for Building Personnel and tenants, as well as system troubleshooting manuals for technicians.
2) Maintenance instructions and procedures of all vertical transportation equipment installed, including parts lists, for each elevator system.
3) Lubrication charts indicating all lubricating points and type of lubricant recommended for all equipment.
4) Complete parts catalogs for all replaceable parts.

d. Elevator Identification
1) Elevators shall be given an individual numbering identity. The number shall be the University 4-digit number followed by an alpha digit assigned to the individual elevator and shown on the record documents.

C. Tools:
1. The following equipment shall be furnished upon completion and before final payment:
a. The Elevator Contractor shall provide all the necessary tools, including laptop, hand-held devices, required software and manuals, required to troubleshoot, adjust, synchronize, calibrate, repair and maintain the vertical transportation systems, as well as perform all necessary procedures to perform all safety tests as required by code and local governing authority.
b. Owner’s equipment and software shall be updated regularly as necessary to properly troubleshoot, adjust, synchronize, calibrate, repair, maintain and test the vertical transportation systems. All equipment and/or software shall be of the same version as issued to technicians maintaining the vertical transportation systems.
c. The Elevator Contractor shall provide a backup copy of any software that resides on the troubleshooting tool.
d. Upon cancellation of service agreement, the Elevator Contractor shall provide all upgrades indicated above.
e. Specialized diagnostic devices used to check the operation of the microprocessor and not permanently attached to the controller, shall be provided as part of the contract and shall become university property.
f. Diagnostic tools or devices requiring “reloading” or “recharging” by the manufacturer shall not be used on a University of Kentucky project.

D. Keys:
1. Four sets of keys to operate all keyed switches and locks shall be furnished upon completion.
2. Keys shall be properly tagged.
3. All keying shall be arranged with the Contractor.
4. Provide one additional set of keys for fire department lock box.

1.6 PERMITS, TESTS AND CERTIFICATES

A. Permits:
1. The Elevator Contractor shall secure the necessary permits required for work to be performed, including work performed by sub-contractors.
2. The Elevator Contractor shall also secure the necessary permits required for the work to be performed to remove any existing devices on the premises.
3. The Elevator Contractor shall obtain and pay for all municipal and state permits necessary for execution of the elevator work, including fees for renewing permits.

4. The Elevator Contractor shall be responsible for posting all permits as required by the AHJ.
5. The Elevator Contractor shall be responsible for obtaining final sign-off for each permit filed by them.

B. Tests and Inspections:
1. The Elevator Contractor shall perform all necessary tests as required by ASME A17.1 and recommended by A17.2.
2. The Elevator Contractor shall be responsible for scheduling the necessary tests as required by the local authorities.
   a. Any fees associated with a missed appointment, expediting of test or overtime test due to delays caused by the Elevator Contractor shall be the responsibility of the Elevator Contractor.
3. When emergency power is provided for the system, the elevators shall be tested under a full load on the generator.
   a. This would include all emergency lighting and other emergency loads connected to the generator.

C. Certificates:
1. Elevator Contractor is responsible for obtaining and providing Contractor with all temporary and final inspection certificates of the proper governing authorities and shall provide the Contractor with such certificates.
2. The Elevator Contractor shall pay for all fees necessary for obtaining temporary and final inspection certificates.

D. Violations:
1. Any violations that exist on devices being removed shall be cleared by the Elevator Contractor prior to final acceptance by the Contractor.

1.7 QUALITY ASSURANCE

A. Compliance with Regulatory Agencies:
1. Comply with most stringent applicable provisions of codes, laws, and/or authorities, including revisions and changes in effect.

B. Inspections:
1. The Contractor is subject to reviews by the Consultant and/or Contractor at any time throughout the project.

1.8 DELIVERY, STORAGE AND HOISTING

A. General:
1. The protection of all equipment and exposed finishes shall be the responsibility of the Elevator Contractor during delivery, handling and installation until completion of project.
2. The Elevator Contractor shall replace damaged materials with new, at no additional cost for material and labor to Contractor.

B. Delivery and Storage:
1. It is expected that manufacturers’ original packing shall adequately protect materials during delivery.
2. Deliver materials to the site ready for use in the accepted manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name and manufacturer's name. Delivered materials shall be identical to accepted samples.

3. Store materials under cover in a dry and clean location, off the ground. Remove delivered materials that are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials.
4. It is the responsibility of the Elevator Contractor to properly store and protect all materials in space provided or designated by the Contractor against damage, stains, scratches, corrosion, weather, construction debris and environmental conditions.

C. Hoisting:
1. All required hoisting and movement of equipment shall be the responsibility of the Elevator Contractor.

1.9 COORDINATION

A. General:
1. Coordinate the following requirements with the other trades.

B. Cast-in-Place Concrete:
1. Elevator Contractor to provide guide rail bracket inserts and the locations for the General Contractor to install.
2. Elevator Contractor to provide templates for machine room slab penetrations.
3. Provide other hoistway and pit requirements, including location of sump pits.

C. Masonry Penetrations:
1. Provide locations in elevator machine room/hoistway walls where conduit, ropes, etc. shall penetrate walls and slabs.
2. Coordinate installation of sleeves, block outs, inserts, and items that are embedded in concrete or masonry for elevator equipment.
3. Furnish inserts, templates and installation instructions and deliver to Project site in time for installation.

D. Structural Steel:
1. Including, but not limited to, elevator machine rooms, hoistways and pits, sill supports, rail supports.

E. Miscellaneous Steel:
1. Pit ladders, working platforms, inspection platforms, guard rails, divider beams.
a. Coordinate requirements for Car 7 and Car 8 extended buffer access platform.

F. Electric:
1. Electrical service, outlets, lights, switches in elevator machine rooms and pits.

G. Sprinklers:
1. Including installation of sprinkler systems in the elevator pits or shaft per NFPA 13.

H. HVAC:
1. Provide necessary information to General Contractor and coordinate installation of equipment for elevator machine rooms.

I. Finishes:
1. Cab interiors, hoistway entrances, fixtures.

J. Elevator Cab Flooring:
1. Material and finish to be specified in other applicable section.

2. Anticipate allow 5 lbs./sf for the 3/8” epoxy terrazzo floor finish. Confirm during submittal process.
3. Flooring installation must be coordinated to ensure car saddle is installed at proper height (even with finished floor).

K. Security Equipment:
1. Coordinate location(s) in elevator machine rooms and cabs where cables, conduit, components, etc. for CCTV and/or secure access interface equipment must be installed.

1.10 WARRANTY

A. Manufacturer’s Warranty:
1. Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

B. Warranty Period: one (1) year from date of Substantial Completion for the last elevator completed:
1. The Elevator Contractor shall guarantee that the materials and workmanship of the apparatus installed by them and any subcontractor under this contract, shall be first class in every respect and that he will make good on any defects not due to ordinary wear and tear or improper use, which may develop within one year from the date of final acceptance of all equipment.
2. Manufacturer’s warranty to repair or replace defective products or their components in the event of defects within a specified period.
3. Neither the final payment nor any provisions of the contract documents shall relieve the Elevator Contractor of the extent and period provided by law and upon written notice he shall remedy any defects due thereto and pay all expenses for any damage to other work resulting there from.
4. The warranty as outlined above, for all devices, shall start from the date of final acceptance of the final elevator completed, by the Consultant and the Owner, of all work specified and intended under these contract documents.
5. Warranty maintenance services shall be completed as identified in Owner’s Maintenance Scope of Work and herein. Refer to Section 143250.

1.11 MAINTENANCE

A. General:
1. All maintenance shall be performed according to the guidelines stated in manufacturer’s Maintenance and Operations manuals.
2. Maintenance records for each device, including lubrication logs, check charts, shall be provided in each machine room.
3. Specifications for Maintenance Agreement outlined in Owner’s Maintenance Scope of Work and identified herein. Refer to Section 143250.

B. Construction Maintenance:
1. Upon substantial completion of a device, subsequent to receiving sign-off from the governing authorities and acceptance from Consultant and/or Contractor, the device may be accepted for service before completion of the entire project.
2. During the Construction Maintenance period, the necessary preventive maintenance shall be performed on an as required basis, as identified in the Owner’s Maintenance Scope of Work.
3. Provide the necessary protection of the hoistway entrances and sills, hoistway fixtures, cab interiors and fixtures and car door sills.

4. Replacement or repair of the aforementioned components, due to abnormal use by others, shall be the responsibility of the Contractor..
5. Construction Maintenance Period:
    1) Refer to Construction Schedule.
6. Include 24-hour-per-day, 7-day-per-week emergency callback service. Refer to Owner's Maintenance Scope of Work for equipment response times.

C. Warranty Maintenance:
1. Upon final acceptance of each device, after Construction Maintenance period (if applicable), subsequent to receiving acceptance (sign-off) from the governing authorities and final acceptance, each device shall be accepted for full operation.
2. The warranty maintenance period shall begin for each device when all conditions in the above paragraph are met and will continue for the specified period.
    a. Warranty Maintenance Period may begin at different times for each elevator.
3. The warranty maintenance program shall include the following:
    a. Monthly examinations, including adjustments, cleaning and lubrication of equipment.
    b. 24-hour Emergency Call back service shall be provided at no additional cost to Owner.
    c. Replacement of components as required, using only components produced by the original manufacturer.
        1) Each machine room shall be equipped with a lockable storage cabinet to contain the necessary spare parts.
    d. Specifications for Warranty Maintenance outlined in Owner's Maintenance Scope of Work is required. Refer to Section 143250.

D. Maintenance Agreement:
1. Upon completion of the Warranty Maintenance period, the Elevator Contractor will provide the personnel to service the vertical transportation equipment.
    a. Full-Service Maintenance Agreement shall commence upon the completion of the warranty maintenance period for a term of five (5) years:
        1) As directed by UK Purchasing. The Contractor shall provide a proposal for a service agreement as per the specifications provided.

PART 2 - PRODUCTS

2.1 REFERENCES

A. Definitions:
1. Terms used are defined in the latest edition of the Safety Code for Elevators and Escalators, ASME A17.1.

B. American National Standard Institute (ANSI):
1. A117.1 - Accessible and Usable Buildings and Facilities.

C. American Society of Mechanical Engineers:
1. ASME A17.1 - Safety Code for Elevators and Escalators.
2. ASME A17.2 – Guide for Inspection of Elevators, Escalators, and Moving Walks.
3. ASME A17.5 – Elevator and Escalator Electrical Equipment.
4. ASME A17.6 – Standard for Elevator Suspension, Compensation, and Governor Systems.

D. National Fire Protection Association (NFPA):
1. NFPA 13 – Installation of Sprinkler Systems.

2. NFPA 70 – National Electric Code.
3. NFPA 80 – Fire Doors and Windows.
4. NFPA 101 – Life Safety Code.

E. Accessibility:
1. Kentucky Building Code (KBC).
2. ADA Standards for Accessible Design.

2.2 MANUFACTURERS

A. The bidder/company hereby agrees that no proprietary situations will be imposed as to the providing to the University's elevator service providers any maintenance drawings, equipment, part, or control items (including circuit boards, chips, diagnostic tools, etc.), etc. required for the maintenance and upkeep of the elevators provided on this project. Further, the items will be sold to the University's elevator service providers at current wholesale costs and without undue delay.

B. Subject to compliance with requirements, provide products by one of the following:
1. Third Party Controllers:
   a. Elevator Controls Corp.
   b. GAL Galaxy.
   c. Smartrise
   d. Virgina Controls
2. Hoistway Entrance:
   a. KONE Incorporated.
   b. Otis Elevator Company.
   c. Schindler Elevator Corporation.
   d. ThyssenKrupp Elevator.
   e. Wittur.
   f. Columbia.
   g. EDI-ECI.
   h. National Elevator Cab and Doors.
   i. Regency Elevator Cabs.
3. Sill
   a. Stainless Steel as manufactured by Plymouth Engineering Shapes of Hopkinsville, Kentucky www.plymouth.com/ or approved substitute.
4. Passenger Elevator Door Equipment (Operators, Tracks, Hangers, and Closers):
   a. GAL.
5. Elevator Car Enclosures: Refer to Allowances
   a. Canton
   b. Columbia
   c. EDI/ECI.
   d. Elite Cabs.
   e. Globe Architectural & Metal.
   f. Hollister Whitney
   g. National.
   h. Peele
   i. Regency Elevator Cabs.
   j. Manufacturers Standard or Designer Collection.
      1) Refer to Allowances
6. Fixtures vandal resistant:
   a. Innovation.
7. Two-Way Communication Device:
   a. Ramtel model RR833-OEM
8. Hoist Machines:

a. Hollister Whitney.
b. =

9. Rope Brakes:
   a. Hollister Whitney
10. Electronic Car Door Safety Edge
   a. Janus Pana40 Plus 3D.

2.3 PERFORMANCE REQUIREMENTS

A. Car Speed:
1. ± 3% of contract speed under any loading condition.

B. Car Capacity:
1. Safely lower, stop and hold 125% of rated load.

C. Car Stopping Zone:
1. ±1/4" under any loading condition.

D. Door Times:
1. Seconds from start to fully open or fully closed:
   a. Cars 1 - 3: Door open 2.6 seconds, door close 3.7 seconds.
   b. Cars 4 - 6: Door open 2.8 seconds, door close 4.2 seconds.
   c. Cars 8, 9, 10, 12: Door open 1.6 seconds, door close 2.4 seconds.
   d. Cars 7, 11: Door open 1.6 seconds, door close 2.7 seconds.

E. Car Floor-to-Floor Performance Time:
1. Seconds from start of doors closing until doors are 3/4 open (1/2 open for side opening doors) and car level and stopped at next successive floor under any loading condition or travel direction:
   a. Cars 1 - 3: 12.0 seconds, floor height 15’- 4”, between floors 4 and 5
   b. Cars 4 - 6: 13.0 seconds, floor height 15’- 4”, between floors 4 and 5
   c. Cars 8, 9, 10, 12: 11.5 seconds, floor height 15’- 4”, between floors 4 and 5
   d. Cars 7, 11: 12.0 seconds, floor height 15’- 4”, between floors 4 and 5

F. Car Ride Quality:
1. Acceleration and Deceleration:
   a. Smooth, constant, and not less than 3.0 feet/second^2 with an initial ramp between 0.5 and 0.75 second.
2. Sustained Jerk:
   a. Not more than 6 feet/second^3 or twice the rate of acceleration.
3. Horizontal and vertical acceleration within car during all riding and door operating conditions.
   a. Not more than 10 peak to peak (adjacent peaks).
4. Measurement Standards:
   a. Measure and evaluate ride quality consistent with ISO 18738, using low pass cutoff frequency of 10 Hz and A95 peak-to-peak average calculations.

G. Noise and Vibration Control:
1. Airborne Noise:
   a. Measured noise level of elevator equipment and its operation shall not exceed 60 dBA inside car under any condition including door operation and car ventilation exhaust blower on its highest speed.
   b. Limit noise level in the machine room and its operation to no more than 80 dBA.

c. All dBA readings to be taken 3'-0" off the floor and 3'-0" from the equipment using the “A” weighted scale.

2. Vibration Control:
   a. All elevator equipment shall be mechanically isolated from the building structure and other components to minimize the possibility of objectionable noise and vibrations being transmitted to occupied areas of the building.

2.4 ELEVATORS

A. Geared Passenger Elevators Description:
   1. Elevator Identification: Cars 1 - 3.
   2. Capacity:
      a. Cars 1 - 3: 4,000 lbs.
   3. Class of Loading:
      a. Cars 1 - 3: Class A.
   4. Contract Speed: 350 fpm.
   5. Roping: 1:1.
   6. Machine: Geared.
   7. Machine Location: Overhead.
   8. Control System: Collective microprocessor-based: Selective collective
   9. Floors Served: Refer to Architectural Drawings
      a. Cars 1 - 3: Front: 00 - 07, Rear: N/A.
   10. Openings: Refer to Architectural Drawings
      a. Cars 1 - 3: Front: 8, Rear: N/A.
   11. Minimum Clear to underside of canopy: 9’- 0” High.
   12. Entrance Size: Refer to Architectural Drawings
      a. Cars 1 - 3: 48”W x 96”H
   13. Entrance Type:
      a. Cars 1 - 3: Single speed, center opening.

B. Geared Service Elevators Description:
   1. Elevator Identification: Cars 4 - 6.
   2. Capacity:
      a. Cars 4 - 6: 6,500 lbs.
   3. Class of Loading:
      a. Cars 4 - 6: Class C3.
   4. Contract Speed: 350 fpm.
   5. Roping: 1:1.
   6. Machine: Geared.
   7. Machine Location: Overhead.
   8. Control System: Collective microprocessor-based: Selective collective
   9. Floors Served: Refer to Architectural Drawings
      a. Cars 4 - 6: Front: 00 - 07, Rear: 00 - 04, 07 - 08
   10. Openings: Refer to Architectural Drawings
      a. Cars 4 - 6: Front: 8, Rear: 7.
   11. Minimum Clear to underside of canopy: 9’- 0” High.
   12. Entrance Size: Refer to Architectural Drawings
      a. Cars 4 - 6: 60”W x 96”H
   13. Entrance Type:
      a. Cars 4 - 6: Two speed, center opening.

C. Geared Passenger Elevators Description:
   1. Elevator Identification: Cars 7 - 8.
   2. Capacity:
      a. Car 7: 4,000 lbs.

b. Cars 8: 3,500 lbs.
3. Class of Loading: Class A.
4. Contract Speed: 350 fpm.
5. Roping: 1:1.
6. Machine: Geared.
7. Machine Location: Overhead.
8. Control System: Collective microprocessor-based: Selective collective
9. Floors Served: Refer to Architectural Drawings
   a. Front: 01 - 03, future stop at 04
   b. Rear: N/A.
10. Openings: Refer to Architectural Drawings
    a. Front: 3, future opening at 04
    b. Rear: N/A.
11. Minimum Clear to underside of canopy: 8'- 0" High.
12. Entrance Size:
    a. Car 7: 48"W x 84"H
    b. Cars 8: 42"W x 84"H
13. Entrance Type: Single speed, center opening.

D. Cars 9, 10 - 12 Geared Passenger Elevators Description:
1. Elevator Identification: Cars 9 - 12.
2. Capacity:
   a. Cars 9, 10, 12: 3,500 lbs.
   b. Car 11: 4,000 lbs.
3. Class of Loading: Class A.
4. Contract Speed: 350 fpm.
5. Roping: 1:1.
6. Machine: Geared.
7. Machine Location: Overhead.
8. Control System: Collective microprocessor-based: Selective collective
9. Floors Served: Refer to Architectural Drawings
   a. Front: 00 - 07, Rear: N/A.
10. Openings: Refer to Architectural Drawings
    a. Front: 7, Rear: N/A.
11. Minimum Clear to underside of canopy: 8'- 0" High.
12. Entrance Size:
    a. Car 11: 48"W x 84"H
    b. Cars 9, 10, 12: 42"W x 84"H
13. Entrance Type: Single speed, center opening.

2.5 MATERIALS

A. Steel:
1. Sheet Steel (Furniture Steel for Exposed Work): Stretcher-leveled, cold-rolled, commercial quality carbon steel, complying with ASTM A366, matte finish.
2. Sheet Steel (for Unexposed Work): Hot-rolled, commercial quality carbon steel, pickled and oiled, complying with ASTM A568/A568M-03.
3. Structural Steel Shapes and Plates: ASTM A36.

B. Stainless-steel:
1. Type 302 or 304 series complying with ASTM A240, with standard tempers and hardness required for fabrication, strength, and durability.
2. Apply mechanical finish on fabricated work in the locations shown or specified, Federal Standard and NAAMM nomenclature, with texture and reflectivity required to match Architect's sample. Protect with adhesive paper covering.

a. No. 4 Satin:
   1) Directional polish finish.
   2) Graining directions as shown or, if not shown, in vertical dimension.
b. Textured:
   1) .050 inches mean pattern depth with bright directional polish (No. 4 satin finish).
   2) 5-SM as manufactured by Rimex Metals.

C. Aluminum:
1. Extrusions per ASTM B221; sheet and plate per ASTM B209.
2. Die Cast Aluminum – ASTM B108, Alloy 356.0, T6.
3. Extruded Aluminum – FS QQ-A 200/8, Alloy 6061, T6.

D. Plastic Laminate:
1. ASTM E84 Class A and NEMA LD3.1, Fire-Rated Grade (GP-50), Type 7, 0.050" ±.005" thick.
2. Exposed Surfaces: Color and texture selected by Architect.
3. Concealed Surfaces: Manufacturer's standard color and finish.

E. Fire-Retardant Treated Particle Board Panels:
1. Minimum 3/4" thick backup for natural finished wood and plastic laminate veneered panels, edged and faced as shown, provided with suitable anti-warp backing
2. Meet ASTM E84 Class "I" rating with a flame-spread rating of 25 or less, and smoke development raring of A or less, registered with Local Authorities for elevator finish materials.

F. Paint Finishes:
1. General:
   a. Clean exposed metal parts and assemblies of oil, grease, scale, and other foreign matter and factory paint one shop coat of standard rust-resistant primer.
   b. Galvanized metal need not be painted.
2. Prime Finish:
   a. Apply one coat of rust-resistant primer followed by a filler coat over uneven surfaces.
   b. Sand smooth and apply final coat of primer.
3. All equipment and metal work installed under this contract, which does not have a baked enamel or special architectural finish, and which is exposed in the hoistway, shall be cleaned and painted one field coat of enamel.
4. All machine room equipment shall be painted upon completion of the installation with the manufacturer's standard machinery enamel.
5. Elevator designation (number and/or letter) shall be prominently indicated on all machine room and machinery space equipment, top of car crosshead and pit equipment.

G. Baked Enamel Finish:
1. Prime finish per above.
2. Unless specified "prime finish" only, apply and bake three additional coats of enamel in the selected solid color.
3. Architect to provide RAL color for painted finishes.
   a. Cars 1 – 3 and 4 – 6: Refer to Architectural Drawings for hoistway door frame and car door finish requirements.

H. Terrazzo tile:
1. Refer to Construction Documents.

2.6 OPERATION

A. General:
1. Cars automatically slow down and stop level at floors in response to car and landing calls with stops made in sequence in the established direction of travel, regardless of order in which buttons are pressed.
2. Landing calls canceled when answered.
3. Automatic Dispatch Failure:
   a. Provide auxiliary dispatch system to automatically dispatch elevators in the event of failure of the primary control system.
4. Hall Call Button Failure:
   a. Should failure of hall call button system occur, initiate operation providing predetermined service to all landings; elevators to respond normally from car call buttons.
5. Automatic Leveling:
   a. An automatic two-way leveling device shall be provided, designed to govern the leveling of the car to within 1/8” above or below the landing sill. The leveling operation shall be effective to avoid overtravel, as well as undertravel of the car and maintain the leveling accuracy regardless of the load in the car, direction of travel, rope slippage or stretch.
6. Door Control:
   a. A car without registered car calls arriving at a floor where both up and down hall calls are registered, responds to the call in the direction of car travel. If no car call is registered for further travel in that direction, lantern immediately indicates changed direction without closing and reopening doors.
   b. Direction lantern to remain illuminated until doors are fully closed.
7. Coincident Calls:
   a. The dispatching system shall be designed with a 20 second parameter, whereby an elevator with a car call will receive priority to answer a corresponding corridor call if it can do so within 20 seconds. If that elevator cannot answer the call within the prescribed time, the first available car shall be assigned.
8. Independent Service:
   a. Provide controls for operation of each car from its pushbuttons only.
   b. Close doors by constant pressure on desired destination floor button or door close button.
   c. Open doors automatically upon arrival at selected floor.
9. Load Weighing:
   a. General:
      1) Provide cars with adjustable cable tension monitoring load weighing device.
      2) Devices must be self-calibrating for the time-dependent effects of compression in any resilient materials in the assemblies, transducers, etc.
      3) Control system to provide dispatching at main floor in advance of normal intervals when car fills to capacity.
      4) Provide hall call by-pass when the car is filled to preset percentage of rated capacity and traveling in down direction.
      5) System shall be provided with field adjustable range, 10 to 100%.
      6) Audible and visual overload signaling device inside elevator cab shall be activated upon load weighing device sensing carload has reached or exceeded a pre-determined percentage of capacity.
      7) Elevator shall not be capable of closing doors and running when Overload signaling device is active.

B. Group Operation
1. Groups:
   a. Cars 1-3: Staff

b. Cars 4-6: Service/Patient Transportation
c. Cars 7-8: Public ASC
d. Cars 9-12: Public CTC

2. General:
   a. Arrange for automatic operation through car and landing buttons in conjunction with a microprocessor-based group supervisory system.
   b. A continuous reassessment of all calls shall be made with the processor having the capability of reassessing a minimum of ten (10) times per second.
3. Group Supervisory System - Passenger Elevators:
   a. The supervisory system shall, through a dispatching algorithm, continually measure the number of corridor calls, their duration, their direction, distance, service to previously assigned car and hall calls, car load, door and car motion status, coincidence of car and hall calls, etc., to determine the intensity of traffic and its direction. The supervisory system shall automatically adjust itself to all demands with preference given to the registered calls in the following order:
      1) Main Landing Demands (of any type or duration).
      2) Long wait Down calls.
      3) Long wait Up calls.
      4) Up calls.
   b. Long wait calls shall be considered those that have been registered for over thirty seconds.
   c. Dynamic zoning strategies may be employed consistent with the aforementioned requirements.
4. Hall Call Assignment:
   a. Assign registered hall calls to car that will provide the best response.
   b. Car assignment and response time determined by computing relative factors such as distance, service to previously assigned car and hall calls, carload, direction, door and car motion status, and coincidence of car and hall calls. Continuously compute these factors and assign best car available to answer call.
   c. A car without registered car calls arriving at a floor, where both up and down hall calls are registered, initially responds to the hall call in the direction that car was traveling. If no car call is registered for further travel in that direction, lantern immediately indicates changed direction without closing and reopening doors.
5. Car / Hall Lantern Signals:
   a. The lantern shall generate signal upon each stop, regardless of responding to car or hall call.
   b. An option shall be provided to allow lanterns to be active in response to hall calls only.
   c. Lantern shall be provided with signal from controller compliant with ADA requirements.
6. Delayed Car:
   a. If, for any reason, a car is delayed after it receives a start signal, system transfers the call to another car.
   b. When cause of delay is corrected car automatically returns to normal operation.

C. Car-to-Lobby Feature:
   1. Provide the means in the firefighters' control panel for automatic return to the main floor. Provide means in remote lobby panel or designated key switch near
   2. Return car nonstop after answering pre-registered car calls, and park with doors open for an adjustable time period of 60-90 seconds.
   3. Upon expiration of time period, car shall automatically revert to normal operation and close doors until assigned as next car or until the car is placed on independent service.

D. Firefighters' Service:
   1. Provide equipment and operation in accordance with code requirements.

E. Interface to Building Management Systems:
1. The elevator monitoring system shall be capable of interfacing and exchanging data with a variety of third party building management systems including Tridium.
   a. Refer to appendix at the end of this specification section.
   b. All associated hardware, software, cabling and conduit for a complete connection to the system is to be included as part of the elevator contract.
   c. Connection is to be made via BacNet/IP, BacNet/MSTP or Modbus protocols or other suitable methods as required.

F. Motion Control:
1. Microprocessor-based AC variable-voltage, variable frequency with digitally encoded closed-loop velocity feedback suitable for operation specified and capable of providing smooth, comfortable car acceleration, retardation, and dynamic braking.
2. Limit the difference in car speed between full load and no load to not more than ±3% of the contract speed.

G. Standby Lighting, Communication, and Alarm:
1. Car mounted battery unit with solid-state charger to operate alarm bell, car emergency lighting, and voice communication system.
2. Car lighting and communication shall be provided with a minimum of 4 hours of operation on back-up power during a loss of normal power, and a minimum of 1 hour of operation for car-mounted alarm and any remote alarm mounted at the designated level.
3. Battery to be rechargeable with minimum five-year life expectancy.
4. Provide constant pressure test button in service compartment of car operating panel.
5. Provide lighting integral with portion of normal car lighting system.
   a. Emergency lighting is not to be installed on car operating panel.

H. Door Operation, All Cars:
1. Automatically open doors when car arrives at a floor.
2. At expiration of normal dwell time, close doors.
3. Reopen doors when car is designated for loading.
4. Cars 4-6, provide front or rear selective door operation.

I. Dual-Mode Operation, Cars 4 - 6:
1. Mode I: Normal Mode – Group of three (3) elevators
   a. Operate within group, responding to group supervisory control assignments.
2. Mode II: “Swing Operation” or Construction Use – One (1) group of two (2) elevators and one (1) elevator operating as a single selective collective car
   a. Operate car as a single, selective collective car from a separate riser of hall pushbuttons.
3. Provide means to select operating mode, single car or group automatic positions.
   a. Provide a key switch located on Fire Command Firefighter’s Control Panel or at Main Lobby hall station as directed by Architect. Utilize a Use Yale 7-pin small format removable core.

J. Priority Hospital Emergency:
1. Provide feature as specified for Cars 4 - 6
2. Operation:
   a. Feature shall be activated via two-position on/off keyed switch, mounted in hoistway entrance jamb at all floors, with key removable in the “off” position only.
   b. Feature shall be activated via proximity sensor located within the lobby hall stations.
   c. Activation of device at any floor shall cause a small blue light jewel or larger jewel with engraved target identifying the operation, to illuminate at that floor and all

other floors and firefighter's control panel and group lobby panel, to indicate operation in use.

d. Activation of device shall cause the control system to assign the nearest car with a demand at the desired level:
   1) If the car is traveling to the demand floor, the car shall express to that floor.
   2) If traveling away, the Car shall stop at the next available floor without opening doors, reverse, and express to that floor without stopping at previously assigned floors.
   3) All registered car and hall calls for selected car shall be cancelled.
   4) All registered car and hall calls for selected car shall be cancelled.

e. A blue light with the engraved signage beneath "Please Exit Car" at the top of the car operating panel shall pulsate and audible annunciation verbiage as selected shall sound, indicating to riding passengers the car has been commandeered for the required service.

f. Upon arrival of car at floor of activation, car shall open its doors and "park" for an adjustable time period of 30-90 seconds:
   1) Provide second initiation device adjacent to blue light in car operating panel for attendant operation of car under priority service feature.
   2) Keyed switch shall be two-position, on/off, with key removable in "off" position only.
      a) Coordinate Code Blue requirements with Owner including engraving instructions and use of key switch or card reader.
   3) Upon activation, car "park time" shall be voided and car shall be under control of attendant.
   4) Registration of a destination floor, followed by the activation of the door close button, shall cause express non-stop travel to selected floor.
   5) Upon arrival at selected floor, car shall open its doors and remain at that floor until another floor is selected, or the priority service switch is returned to the "off" position, or the "park" time has completed.
   6) Failure to activate car priority keyswitch in the elevator at the original demand floor within preset time constraints of 30-90 seconds or returning car switch to "off" position, shall cause car to be automatically restored to normal service.

K. Utilize corrosion-resistant finishes for all other elevator components.

L. Standby Power Operation:
1. Upon loss of normal power, adequate standby power will be supplied via building electrical feeders to start and run four (4) elevator simultaneously.
   a. Upon loss of normal power, adequate standby power will be supplied via building electrical feeders to start and run Elevators 4, 5, and 6 simultaneously at contract car speed and capacity.
   b. Upon loss of normal power, adequate standby power will be supplied via building electrical feeders to start and one (1) additional elevator, Elevator 1 - 3, 7 - 8, or 9 – 12, simultaneously with Cars 4, 5, and 6, at contract car speed and capacity.
2. Automatically return cars, nonstop to designated floor, open doors for approximately 3.0 seconds, close doors, and park car.
3. During return operation, car and hall call pushbuttons shall be inoperative.
4. As cars park, system shall immediately select the next car within the sequence until all cars have returned to the designated floor.
5. If a car fails to start or return within 30 seconds, system shall automatically select the next car in the sequence to return.
6. When all operable cars have returned to the designated floor, Cars 4, 5, 6 and one additional car, Car 1 – 3, 7 – 8, or 9 – 12, shall be designated for automatic operation.

When demand exists for 30 seconds and designated car fails to start, next available car shall be automatically selected for operation.

7. Provide separate group selection key switches in firefighters' control panel.
   a. Switches shall be labeled "STANDBY POWER OVERRIDE" with positions marked "AUTO" and appropriate car numbers controlled by each respective switch.
   b. Key shall be keyed the same as differently from the key utilized for firefighters' Phase I and II key switch. Key shall be removable in "AUTO" position only.
   c. Switch shall override automatic return and automatic selection functions and cause the manually selected car to operate.
   d. Manual selection shall cause car to start and proceed to designated floor and open and close its doors before standby power is manually transferred to next selected car.
   e. Engraving shall clearly identify cars included in a group, with group and car identification as approved by Architect.
8. Provide "STANDBY POWER" indicator lights, one per car, in firefighters' and security control panels.
   a. Indicator light illuminates when corresponding car is selected, automatically or manually, to operate on standby power.
9. Provide control logic, conduit, and wiring to provide required sequences, between all cars and groups.
   a. Provide intergroup monitoring required for operation.
10. Successive Starting: When normal power is restored or there has been a power interruption, individual cars in each bank shall restart at five-second intervals.

M. Floor Lockout:
1. Provide means to limit access to building floors for Cars 4-6 as follows
   a. Provide lock-out keyed switch on the Penthouse push button
      1) The push button is to be activated by the keyed switch
      2) Key shall not be removable in the activation position.
         a) Alternate configuration
            (1) For unrestricted elevator service to the penthouse, provide a keyed switch to over-ride the Penthouse mechanical room keyed button lock-out switch;
            (2) Key shall be removable in all positions
            (3) Use Yale 7-pin small format removable core. Place over-ride switch in the top area of the car panel.
   b. Wire controls so as not to interfere with Fire Service operation.
   c. Provide temporary inactivated push buttons for each floor even if a key switch, card reader, and/or other devices are required.
   d. Individual floor lockout means in main car operating panel and security control panel to prevent registration of car calls to any selected secure floor.
   e. Arrange system so that independent service and/or attendant operation overrides security system.
      1) Confirm functionality of override during submittal process
   f. Arrange system so that firefighters' service overrides security system.
   g. Actuate hall lantern each time car arrives at main lobby during secure mode operation.
   h. Provide warning light and/or signal in group control panel to indicate an attempt to register unauthorized destinations or to open car doors when car is moving or parked at a secured floor.
   i. Provide reset switch or button to cancel warning light and signal.

N. Card/Proximity Reader Security System:
1. Provide provisions inside Cars 1 - 3, 4 - 6 for reader unit.

a. Mount reader unit as directed by Architect and make cross connects to card reader terminal interface and relays in machine room.
b. Provide filler plate to match card slot size or proximity reader size and car return panel finish, including direction of graining, where card slot or proximity reader cutout is not initially utilized.

2. Hall Station Access Controls, Cars 4 – 6:
   a. Provide provisions to incorporate card readers at each hall station.
   b. Card readers may be used for access controls or to initiate special operation modes including VIP services (empty car call) or Code Blue amongst other features.
3. Elevator control systems shall provide output signal of selected floor to facilitate system tracking of floor access.

O. AGV Integration:
   1. Not required.

2.7 MACHINE ROOM SPACE EQUIPMENT

A. Arrange equipment in spaces shown on drawings.

B. Geared Traction Hoist Machine and Motor:
   1. Single worm geared or helical geared traction type with AC induction or P.M.S.M. ACV³F motor, brakes, gear, drive shaft, deflector sheave, and gear case mounted in proper alignment on an isolated bedplate.
      a. Incorporate isolation design shown in documents.
   2. Provide bedplate blocking to elevate secondary or deflector sheave above machine room space floor.
   3. Provide hoist machine mounted direct drive, digital, closed-loop velocity encoder.
   4. Provide hoist machine drip pans to collect lubricant seepage.
   5. Provide machine with disc brake and secondary emergency brake:
      a. Provide means to prevent ascending car over speed and unintended car movement.
      b. Mount emergency brake on geared machine frame bed or suitable structural steel supports.
      c. Acceptable emergency brake devices:
         1) Hollister Whitney Rope Gripper.
      d. Provide drawing showing supports stamped by a Professional Engineer verifying the adequacy of the support provided if emergency brake device is not mounted by machine Original Equipment Manufacturer.

C. Solid State Power Conversion and Regulation Unit:
   1. Provide solid-state, alternating current, variable voltage, variable frequency (ACV³F), IGBT converter/inverter regenerative drive.
   2. Design unit to limit current, suppress noise, and prevent transient voltage feedback into building power supply:
      a. Provide internal heat sink cooling fans for the power drive portion of the converter panels.
      b. Conform to IEEE standards 519-2014 for line harmonics and switching noise.
   3. Mechanically isolate unit to minimize noise and vibration transmission.
   4. Provide isolation transformers, filter networks, and choke inductors.
   5. Suppress solid-state converter noises, radio frequency interference, and eliminate regenerative transients induced into the mainline feeders or the building standby power generator.
   6. Supplemental direct-current power for the operation of hoist machine brake, door operator, dispatch processor, signal fixtures, etc., from separate static power supply.

7. ACV³F Drives shall be regenerative and utilize IGBT converter/inverter and dynamic braking during overhauling condition.

D. Resistor Load Bank:
   1. Provide means of diverting regenerated power during emergency power operation and restoring regenerated power delivery back to the electrical distribution system following emergency power operation termination.
   2. Provide resistor load bank to discharge regenerative power during emergency power operation.
   3. Load bank shall be installed on the load side of the mainline disconnect.

E. Encoder:
   1. Direct drive, solid-state, digital type. Update car position at each floor and automatically restore after power loss.

F. Controller:
   1. UL/CSA labeled.
   2. Compartment:
      a. Securely mount all assemblies, power supplies, chassis switches, relays, etc., on a substantial, self-supporting steel frame.
      b. Completely enclose equipment with covers.
      c. Provide means to prevent overheating.
   3. Relay Design:
      a. Magnet operated with contacts of design and material to insure maximum conductivity, long life, and reliable operation without overheating or excessive wear.
      b. Provide wiping action and means to prevent sticking due to fusion.
      c. Contacts carrying high inductive currents shall be provided with arc deflectors or suppressors.
   4. Microprocessor Hardware:
      a. Provide built-in noise suppression devices that provide a high level of noise immunity on all solid-state hardware and devices.
      b. Provide power supplies with noise suppression devices.
      c. Isolate inputs from external devices (such as pushbuttons) with opto-isolation modules.
      d. Design control circuits with one leg of power supply grounded.
      e. Safety circuits shall not be affected by accidental grounding of any part of the system.
      f. System shall automatically restart when power is restored.
      g. System memory shall be retained in the event of power failure or disturbance.
      h. Equipment shall be provided with Electro Magnetic Interference (EMI) shielding within FCC guidelines.
   5. Wiring:
      a. CSA labeled copper for factory wiring.
      b. Neatly route all wiring interconnections and securely attach wiring connections to studs or terminals.
      c. Provide labels for all extra or spare wires, neatly organized at base of controller cabinet.
   6. Diagnostics:
      a. Provide an onboard monitor or screen, either inside the controller or in a stand-alone PC station, to display an easily understood format.
      b. Upon command, the current operating parameters, individual car status, floor positions or other selected operational features will be displayed.

c. A display function shall be provided to reference a minimum of twenty (20) previous errors (malfunctions), which will be transmitted to the group dispatcher data log for statistical purposes or selected hard copy printouts.
   1) A color printer shall be provided on site.
d. Diagnostic display shall be programmed for monitoring of elevator motion, velocity, door operation parameters and timing functions.
   1) Provisions shall be made to allow printing of this information at Owner's request.
e. Non-volatile memory shall be used to store group operation data with provisions for data logging and hard copy reporting.
f. A telephone data link provision shall be incorporated in the basic dispatching control system.
   1) At the Owner's request, this provision may be employed for traffic analysis, hard copy computation and/or remote monitoring of status conditions utilizing an isolated PC and compatible printer for reports or graphs.
   2) All reports shall be time and date stamped to confirm reporting period.
g. Monitor shall employ color video displays for the following information:
   1) Display screen (group operations statistics).
   2) Monitoring screen (diagnostics, system status).
   3) Performance screen (traffic analysis).
h. Features required regarding remote and additional location monitoring, as indicated in other applicable sections, apply.

7. Permanently mark components (relays, fuses, PC boards, etc.) with symbols shown on wiring diagrams.
8. Provide control panel compliant with UL 508A SB.SCCR of 5000A required.

G. Electrical Wiring and Wiring Connections:
1. Auxiliary Disconnect:
   a. Provide controller or machine mounted auxiliary, lockable "open" disconnect when machine is not visible from machine. Provide coordinated layout.
2. Conductors and Connections:
   a. Copper throughout with individual wires coded and connections on identified studs or terminal blocks.
   b. Use no splices or similar connections in wiring except at terminal blocks, control compartments, or junction boxes.
3. Conduit:
   a. Use only rigid conduit in the elevator machine room for main power equipment. Minimum conduit size of ¾".
   b. EMT may be used for low-voltage control wiring.
   c. Galvanized steel conduit, EMT, or duct.
   d. Flexible conduit length not to exceed 3'-0".
4. Traveling Cables:
   a. Tag spares in machine room.
   b. Provide cables from controller to car top.
5. Auxiliary Wiring:.
   a. Provide machine room demarcation junction boxes for the fire alarm initiating devices, emergency two-way communication system, firefighters' phone, paging speaker, CCTV, digital video display, security system and card reader interface terminals and relays, intercom, announcement speaker and/or background music.
   b. Provide conduit, wiring and connections for the fire alarm initiating devices, emergency two-way communication system, firefighters' phone, paging speaker, CCTV, digital video display, security system and card reader interface terminals and relays, intercom, announcement speaker and/or background music from machine room junction box to each car controller in machine room

H. Sleeves and Guards:
1. Provide 4" steel angle guards around cable or duct slots through floor slabs or grating.
2. Provide rope and smoke guards for sheaves, cables, and cable slots in machine room.
3. Configure guards to minimize free area around cables.

I. Machine and Equipment Support Beams:
1. Refer to structural drawings.
2. Provide structural steel beams required for direct support of and attachment to building structure of hoist machine, deflector sheaves, overhead sheaves, governor, and hoist rope dead-end hitch assemblies.
3. Provide bearing plates, anchors, shelf angles, blocking, embedment, etc., for support and fastening of machine beams or equipment to the building structure.
4. Isolate machine beams to prevent noise and vibration transmission to building structure.
5. Provide ladders and platforms with handrails and toe boards for machine access within the confines of the machine room.

J. Sheaves:
1. Machined grooves and sealed bearings.
2. Provide mounting to machine beams, machine bedplate, or building structure.

K. Structural Floor:
1. Refer to structural drawings.
2. Provide template for equipment layout.

L. Governor:
1. Centrifugal-type, car machine room mounted with pull-through jaws and bi-directional shutdown switches.
2. Provide required bracketing and supports for attachment to building structure.

2.8 HOISTWAY EQUIPMENT

A. Guide Rails:
1. Planed steel T-sections for car and counterweight of suitable size and weight for the application, including brackets for attachment to building structure.
2. Provide rail backing and intermediate counterweight tie brackets.
3. Provide bracketing, at top and bottom of floor beams.
4. No additional structural points of attachment other than those shown on the Contract Documents will be provided.
   a. Review structural drawings.
   b. Note increased rail weight to achieve bracket spacing.
   c. Hoistway widths are fixed. Include all costs associated with installation in code compliant dimensions shown in Construction Documents.

B. Counterweight:
1. Steel frame with metal filler weights.
2. Provide Type “B” safety device.

C. Counterweight Guide Shoes:
1. Spring dampened roller guide shoes.

D. Counterweight Runway Guard:
1. Where counterweight is located between adjacent elevators, provide counterweight guard along entire runway next to the adjacent elevator.

E. Governor Rope and Encoder Tape Tensioning Sheaves:
1. Mount sheaves and support frame on pit floor or guide rail.
2. Provide frame with guides or pivot point to enable free vertical movement and proper tension of rope and tape.

F. Suspension Means:
1. 8 x 19 or 8 x 25 Seale construction, traction steel type:
a. Fasten with staggered length, adjustable, spring isolated wedge type shackles.

G. Terminal Stopping:
1. Provide normal and final devices.

H. Electrical Wiring and Wiring Connections:
1. Conductors and Connections:
a. Copper throughout with individual wires coded and connections on identified studs or terminal blocks.
b. Use no splices or similar connections in wiring except at terminal blocks, control compartments, or junction boxes.
c. Provide 20% spare conductors for each wire type.
d. Run spare wires from car connection points to individual elevator controllers in the machine room.
2. Conduit:
a. Galvanized steel conduit, EMT, or duct.
b. Flexible conduit between isolated equipment, length not to exceed 3’-0”.
c. Flexible heavy-duty service cord may be used between fixed car wiring and car door switches for door protective devices.
d. Provide conduit from the closest hoistway of each elevator group or single elevator to the firefighters’ control room and group control console.
e. Provide wiring.
3. Traveling Cables:
a. Flame and moisture-resistant outer cover.
b. Prevent traveling cable from rubbing or chafing against hoistway or equipment within hoistway.
c. Provide the following composition at a minimum, which shall not be considered spares:
1) Five pair of shielded 20-guage wire for card reader.
2) Two pair of shielded 18-gauge wire for CCTV, from car controller to car top junction box, plus 3'-0" excess loop at both ends.
3) Two pair of 18-gauge wire for CCTV power.
d. Provide four pair of spare shielded communication wires in addition to those required to connect specified items.
e. Tag spares in machine room. Provide cables from controller to car top.
f. Support traveling cable by suspending from supports by means that automatically tighten around the cable when tension is increased.
4. Auxiliary Wiring:
a. Provide conduit, wiring and connections for systems defined within Section 2.8, H.

I. Entrance Equipment:
1. Two-point hanger roller with non-metallic roller surface and suspension with eccentric upthrust roller adjustment.
2. Bar or formed, cold-drawn removable steel door tracks with smooth roller contact surface.
3. Dust Cover:
a. Provide dust covers at hoist way entrances that conceal the hoist way door tracks and interlocks.

b. Provide covers no less than the width of the door opening plus 12”. Mount covers securely to the header by use of metal screws with keyhole openings.
c. Cover shall be capable of being removed without need of removing screws entirely.

4. Door Interlocks:
   a. Operable door locks without retiring cam.
5. Door Closers:
   a. Spring jamb/strut mounted type.
   b. Design and adjust to ensure a smooth and quiet mechanical close of doors.
6. Future Landing, Cars 7 and 8 Floor 04: see Part 2.9.L

J. Floor Numbers:
1. Stencil paint 4" high floor designations in contrasting color on inside face of hoistway doors and hoistway fascia visible from within car.

2.9 HOISTWAY ENTRANCES

A. Entrance Assemblies:
1. Complete entrances bearing fire labels from a certified testing laboratory approved by authority having jurisdiction.
2. Provide entrance assemblies bearing 1-1/2hr UL label.
3. Paint all exposed metal in hoistway ferrous metal black.

B. Frames:
1. 14-gauge hollow metal at all floors.
2. Bolted and lapped head to jamb assembly at all floors.
3. Cars 1 - 3, 4 - 6: Provide finish material indicated in finish schedule Item 2.5, G., at floors.
4. Provide Arabic floor designation/Tactile marking plates:
   a. Centered at 60" above finished floor.
   b. Located on both side jambs of all entrances.
   c. Minimum 4” in height.
   d. Tactile marking indications shall be below Arabic floor designation.
   e. Permanently fastened.
5. Provide plates at main egress landing with “Star” designation.
   a. For designated emergency cars, Car 4-6, provide “Star of Life” cast designation plates at height of 78"-84" above finished floor on both side jambs at all floors.
6. For designated Fire Service Access Elevators, Cars 4-6, provide fire service access elevator symbol cast designation plates at height of 78"-84" above finished floor on both side jambs at all floors.

C. Transom Panels:
1. Not required.
2. Architectural element above door frame to match door frame, door panel, hall fixtures, and signage as permitted by code.

D. Door Panels:
1. 16-gauge steel, sandwich or pressed with ribbed construction and without binder angles.
2. Provide one leading edge of doors with rubber astragal.
3. Provide a minimum of two gibs per panel, one at leading and one at trailing edge with gibs in the sill groove entire length of door travel.
4. Provide one separate 4” steel reinforcement safety gib mounted between door gibs, where not integrated with door gibs.
5. Cars 1 - 3 and 4 - 6, Architectural finish around leading and trailing edge of panel and return a minimum of 1/2" on rear side of leading edge of panel at all floors.
   a. Refer to 2.5.G. and Architectural Drawings.

E. Sight Guards:
1. 14-gauge, same material, finish, and height as hoistway entrance door panels.
   a. Cars 1 - 3 and 4 - 6: Refer to RAL color provided by architect
   b. Cars 7 - 8, 9 - 12: Brushed stainless steel
2. Construct without sharp edges.

F. Sills:
1. Extruded stainless steel.
2. Refer to approved manufacturers.

G. Sill Supports:
1. Structural or formed steel designed to support door sill based upon car loading classification.
2. Grout sills in place with using a non-shrink, non-metallic grout.
3. Cars 4-6: Provide 5" x 5" x 1/2" structural steel angle, extending full width of hoistway. Fasten to building structure at maximum 18" O.C.

H. Fascia, Toe Guards and Hanger Covers:
1. 14-gauge furniture steel with black enamel Contractor's standard finish.
2. Provide hoistway width fascia, toe guards, and hanger covers for All Cars.
3. Mount covers securely to the header by use of metal screws with keyhole openings.
4. The cover shall be capable of being removed without need of removing screws entirely.
5. Delete fascia for Cars 4-6 and provide car door interlock to prevent opening of car doors outside the unlocking zone.

I. Struts and Headers:
1. Provide all support of entrances and related material to building structure.
2. Provide door open bumpers on entrances equipped with vertical struts.

J. Finish of Frames and Doors:
1. Cars 1 - 3, 4 - 6
   a. Baked enamel.
   b. Provide finish as defined:
      1) Architect to provide RAL color code.
      2) Provide matching fixture faceplates when permitted by code.
2. Cars 7 - 8, 9 - 12
   a. Satin finish stainless-steel.

K. Hoistway Access:
1. Hoistway Door Unlocking Device:
   a. Provide unlocking device with locking escutcheon in door panel at all floors, with finish to match adjacent surface.
2. Hoistway Access Switches:
   a. Mount in entrance frame side jamb at top floor.
      1) Include provisions for Car 7 and Car 8 at upper terminal landing served hoistway door frame (Level 03) and future upper terminal landing hoistway door frame (Level 04).
   b. Provide switch with faceplate, finish to match adjacent surface.

L. Future Landings
   a. Cars 7 - 8, Floor 04: provide hoistway equipment and entrance equipment for future landing. Landing will not be operational and will be sealed from the inside of the hoistway to prevent operation.

1) Include provisions for future installation of hoistway access key switches in door frame.

2.10 PIT EQUIPMENT

A. Buffers:
1. Provide Oil Spring type with blocking and support channels.

B. Pit Access:
1. Hoistway Access Key Switch:
a. Provide key switch at lowest terminal landing.
b. Mount in entrance frame side jamb.
c. Provide switch with faceplate, finish to match adjacent surface.
2. Provide pit stop switches.
3. Pit access, Cars 7 and 8: Provide pit access door switch configured to effectively remove power to elevators in the event of pit access door operation.

C. Float Switches:
1. Float switches shall be provided in each single climb-in elevator pit or lowest point of common climb-in pit.
2. Activation of pit float switch shall cause signal activation to Building Automation System.
3. Flood operation is not required.

D. Equipment Access:
1. Stencil car number on buffer.
2. Provide pit ladder Cars 1 - 3, 4 - 6, 9 - 12: Coordinate code compliant location.
3. Access ladders and platforms, Cars 7 – 8: Provide access ladders and platforms for buffers and undercar.

E. Counterweight Guard:
1. Metal guard in pit in front of counterweight where no compensation is provided or where there is no space greater than 20 inches between the compensation means, suspension means, counterweight rails, or guard(s).

2.11 CAR EQUIPMENT

A. Frame:
1. Welded or bolted or formed steel channel construction to meet load classification specified.

B. Safety Device:
1. Type “B,” flexible guide clamp.

C. Platform:
1. Design and construct to accommodate load classification requirements:
a. Cars 1 - 3, 7 - 12: Provide Class “A” construction for passenger elevators
b. Cars 4 - 6: Provide Class C3 construction for service elevators
c. Provide recess to accommodate a 3/8” epoxy terrazzo floor finish.
d. Provide floor weight allowance as identified in Front End Documents – Allowances.
1) Allow 5 lbs. per square foot for floor weight.
2. The car platform shall consist of a steel frame with necessary steel stringers, all securely welded together.
3. Provide platform with two (2) layers of 3/4" marine grade plywood.
4. Cover the underside of the car platform with sheet steel.

5. Isolate the passenger elevator platform.
   a. The support frame shall carry rubber pads on which the platform shall rest without any connection to the steel frame.
6. Work Light Fixtures and AC Receptacles:
   a. Provide permanent mounted work light fixtures below platform, complete with proper lamp guards.

D. Platform Guard:
1. Minimum 14-gauge steel, reinforced and braced to car platform front and rear with Manufacturer's standard finish.

E. Cartop Guard Rail:
1. Provide a railing system provided on the outside perimeter of the car top on all sides where the horizontal distance between the edges of the car top and the adjacent hoistway enclosure exceeds 12 in..

F. Passenger Guides:
1. Roller type with three or more spring dampened, sound-deadening rollers per shoe. Minimum 6" outside diameter.
2. Maximum roller rotation speed: 350 rpm.

G. Cab Steadying Plates:
1. Provide and install top of car steadying plates.
2. Emphasis shall be placed on proper tension to car styles allowing minimal lateral movement of the cab.
3. Steadying plates shall be isolated using non-metallic guides or rollers.

H. Sills:
1. One-piece extrusion with extension between car entrance columns to face of car front return.
2. Extruded extension to match finish of sill.
3. All Cars: Stainless Steel

I. Door Panels:
1. 16-gauge steel, sandwich or pressed with ribbed construction and without binder angles.
2. Provide one leading edge of doors with rubber astragal.
3. Provide a minimum of two gibs per panel, one at leading and one at trailing edge with gibs in the sill groove entire length of door travel, where not integrated with door gibs.
4. Construct door panels with interlocking, stiffening ribs.

J. Door Hangers:
1. Two-point suspension.
2. Hanger roller with non-metallic surface and eccentric roller adjustment.

K. Door Track:
1. Bar or formed, cold-drawn removable steel track with smooth roller contact surface.

L. Door Header:
1. Construct of minimum 12-gauge steel, shape to provide stiffening flanges.

M. Door Electrical Contact:
1. Prohibit car operation unless car door is closed.

2. Provide car door interlock to prevent opening of car doors outside the unlocking zone, where clearance between the car platform and hoistway enclosure exceeds code maximum on the loading side.

N. Door Clutch:
1. Heavy-duty clutch, linkage arms, vane assembly and pickup rollers or cams to provide positive, smooth, quiet door operation.

O. Restricted Opening Device:
1. Provide mechanical car-door restrictor to prevent opening of doors when outside unlocking zone.

P. Door Operator:
1. High speed, heavy-duty door operator capable of opening doors at no less than 2.5 f.p.s.
2. Accomplish reversal with less than 2½" of door movement.
3. Provide solid-state door control with closed loop circuitry to constantly monitor and automatically adjust door operation based upon velocity, position, and motor current.
4. Provide a minimum of four controller-based motion profiles, per floor, per door, to maintain consistent, smooth, and quiet door operation at all floors, regardless of door weight or varying air pressure.

Q. Door Reversing Device:
1. Infrared Reopening Device:
   a. Black fully enclosed device with full screen infrared matrix or multiple beams extending vertically along leading edge of each door panel to minimum height of 7'-0" above finished floor.
      1) Provide extension of housing and lens additional beams full height of door panels for door heights greater than 7’ – 0” tall.
   b. Device shall prevent doors from closing and reverse doors at normal opening speed if beams are obstructed while doors are closing, except during nudging operation.
   c. In event of device failure, provide for automatic shutdown of car at floor level with doors open.
2. Nudging Operation:
   a. After beams of door control device are obstructed for a predetermined time interval (minimum 20.0-25.0 seconds), warning signal shall sound, and doors shall attempt to close with a maximum of 2.5 foot-pounds kinetic energy.
   b. Activation of the door open button shall override nudging operation and reopen doors.
3. Interrupted Beam Time:
   a. When beams are interrupted during initial door opening, hold door open a minimum of 3.0 seconds.
   b. When beams are interrupted after the initial 3.0 second hold open time, reduce time doors remain open to an adjustable time of approximately 1.0-1.5 seconds after beams are reestablished.
4. Differential Door Time:
   a. Provide separately adjustable timers to vary time that doors remain open after stopping in response to calls.
   b. Car Call:
      1) Hold open time adjustable between 3.0 and 5.0 seconds.
   c. Hall Call:
      1) Hold open time adjustable between 5.0 and 8.0 seconds.
      2) Use hall call time when car responds to coincidental calls.

R. Car Operating Panel:

1. All Cars:
   a. Two (2) car operating panels with faceplates:
      1) Consisting of a metal box containing the vandal resistant operating fixtures, mounted behind the car stationary front and rear return panels.
   b. Suitably identify floor buttons, alarm button, door open button, door close button and emergency push-to-call button with cast tactile symbols recessed rear mounted.
      1) Push button designation shall match the architectural floor designation.
   c. Provide “door open” button to stop and reopen doors or hold doors in open position.
   d. Provide “door close” button to activate door close cycle.
      1) Cycle shall not begin until normal door dwell time for a car or hall call has expired, except firefighters’ operation.
   e. Pushbuttons:
      1) Provide vandal resistant with minimum 3/4" diameter raised floor pushbuttons which illuminate to indicate call registration.
      2) Provide brushed stainless buttons with illuminated LED halo.
      3) Provide temporary inactivated push buttons for each floor even if a key switch, card reader, and/or other devices are required.
         a) Provide space for push buttons for future landings not currently served.
      4) Service Elevators:
         a) For restricted access to a Penthouse mechanical room, provide lock-out momentary keyed switch on the Penthouse push button. The push button is to be activated by the keyed switch. Key shall not be removable in the activation position.
            (1) 7-pin Yale with removable core for MPPD.
         b) For unrestricted elevator service to the penthouse, provide a keyed switch to over-ride the Penthouse mechanical room keyed button lock-out switch; key shall be removable in all positions. Use 7-pin small format removable core. Place this over-ride switch in the top area of the car panel..
            (1) Confirm YALE or BEST with Owner.
      5) Future Travel, Cars 7 – 8: Include space in car operating panel to accommodate additional landing served if future travel is added. Provide blanks to allow for installation without drilling car operating panel.
   f. Locate operating controls no higher than 48" above the car floor; no lower than 35" for emergency push-to-call button and alarm button.
   g. Locked Firefighters Operation Panel:
      1) For fire officer use and use of car on independent service only.
      2) Openable by the same key which operates the Fire Operation switch.
      3) Including the following features:
         a) Phase II fire access switch.
         b) Firefighters’ visual indication.
         c) Call cancel button.
         d) Stop switch, manually operated.
            (1) Key should be removable in all positions; use 7-pin Yale with removable core for MPPD
            (2) Position the cylinder near the bottom of the pushbuttons with the key removable in either position and with one set of normally closed contacts.
            (3) Mark the switch with etched, engraved, or embossed “ON” and “OFF.”
         e) Door open button.
         f) Door close button.

4) Arrange manually operated stop switch to sound group control panel distress signal when actuated.

2. Service Compartment (all cars):
   a. Provide lockable service compartment with recessed flush door.
      1) Key should be removable in all positions; use Best Cylinder with removable core 7-pin Yale with removable core for MPPD and include slam door lockset.
   b. Door material and finish shall match car return panel or car operating panel faceplate.
   c. Include the following controls in lockable service cabinet with function and operating positions identified by permanent signage or engraved legend:
      1) Access switch.
      2) Light switch.
      3) Two speed fan, 3-position two-speed Exhaust blower switch
         a) Key should be removable in all positions; use Best Cylinder with removable core 7-pin Yale with removable core for MPPD.
      4) Independent service switch.
      5) Constant pressure test button for battery pack emergency lighting.
      6) 120-volt, AC, GFCI protected electrical convenience duplex outlet.
      7) Card reader override switch.
      8) Switch to select either floor voice annunciation, floor passing tone, or chime.
3. All Cars: Provide black paint filled (except as noted), engraved, or approved etched signage as follows with approved size and font:
   a. Phase II firefighters' operating instructions on inside face of firefighters' compartment door.
   b. Engrave filled red firefighters' operation on outside face of compartment door.
   c. Building identification car number on main and auxiliary car operating panel.
   d. Car capacity in pounds on main car operating panel service compartment door.
   e. Cars 4-6: Loading classification and description on car operating panel service compartment door.
   f. Provide special language engraved pertaining to the posting of the Elevator Permit.
4. All Cars: Load weighing:
   a. Audible and visual overload signaling device inside elevator cab shall be activated upon load weighing device sensing carload has reached or exceeded a pre-determined percentage of capacity.
   b. Include engraving to identify visual overload signaling device.
5. Priority Hospital Emergency, Cars 4 – 6:
   a. Refer to 2.6.I. Incorporate Priority Hospital Emergency visual indicator, instructions, and means to activate feature in Car Operating Panel.

S. Car Top Control Station:
   1. Mount to provide safe access and utilization while standing on car top.
   2. Operating device shall contain Up and Down direction buttons, a Run button, an Inspection/Automatic switch and Emergency Stop switch.
   3. Operating device shall contain an audible and visible indicator that fire recall has been initiated.
   4. This station shall be fixed to the car crosshead or may be portable provided the extension cord and housing is permanently attached to the car crosshead.
   5. The car will be operated by constant pressure on the appropriate directional button and the Run button simultaneously.
   6. Normal operating devices will be inoperative while this device is in use.

T. Emergency Audible Signal:
   1. Provide on top of each elevator.

2. Activation of Alarm Button or Emergency Stop switch will cause Emergency Audible Signal.
3. Provide battery back-up system to provide 1hr power in the event of loss of normal power.
4. Provide second alarm to be provided at pit level.

U. Work Light and Duplex Plug Receptacle:
1. GFCI protected outlet at top and bottom of car.
2. Include on/off switch and lamp guard.
3. Provide additional GFCI protected outlet on car top for installation of car CCTV.

2.12 CAR ENCLOSURE

A. Passenger Elevators, Cars 1 – 3, 7 - 8, 9 - 12: Provide complete as specified herein and detailed on architectural drawings:
1. Refer to Allowances
2. Shell:
   a. Reinforced 14-gauge furniture steel formed panels with baked enamel interior finish as selected.
   b. Apply sound-deadening mastic to exterior.
   c. Provide concealed ventilation cutouts.
3. Canopy:
   a. Reinforced 12-gauge furniture steel formed panels with lockable, contacted, hinged emergency exit.
   b. Interior finish white color reflective baked enamel.
4. Front Stationary Return Panels:
   a. Reinforced 14-gauge furniture satin stainless-steel with minimum 16-gauge with cutouts for applied car operating panels and other equipment.
5. Transom:
   a. Reinforced 14-gauge furniture steel clad with minimum 16-gauge satin stainless-steel full width of enclosure.
6. Base:
   a. Stainless-steel with concealed ventilation cutouts.
7. Finish Floor Covering:
   a. Furnished under other sections.
   b. Accommodate a minimum 3/8" floor thickness.
   c. Allow 5lbs./ft^2 for floor weight.
8. Interior Wall Finish:
   a. Include allowance for interior car finishes.
9. Ventilation:
   a. Morrison Products, Inc. two-speed model exhaust blower mounted to car canopy on isolated rubber grommets.
   b. Exhaust blower shall meet noise and vibration criteria.
10. Lighting:
   a. Include allowance for lighting.
   b. Coordinate with emergency lighting requirements.
11. Suspended Ceiling:
   a. Special design included in allowance in Item 8 above.
12. Handrails:
   a. Special design included in allowance in Item 8 above.
13. Pads and Buttons, All Cars:
   a. Three-piece removable pads.
   b. Two pads covering side walls and adjacent front returns and one covering rear wall.
   c. Provide cutouts to access main car operating panel.

B. Firefighter's Elevator, Service Elevators, Cars 4 - 6: Provide complete as specified herein:
   1. Provide watertight components.
   2. Shell:
      a. Reinforced 14-gauge satin finish stainless-steel formed panels no more than 18" wide with light-proof joints.
      b. Apply sound deadening mastic to exterior.
   3. Canopy:
      a. Reinforced 12-gauge furniture steel formed panels with lockable, contacted, hinged emergency exit.
      b. Interior finish white reflective baked enamel.
   4. Front and Rear Stationary Return Panels:
      a. Reinforced 14-gauge furniture steel clad with minimum 16-gauge textured finish stainless-steel as specified in Item 2.3.
   5. Entrance Columns and Transom:
      a. Reinforced 14-gauge furniture steel clad with minimum 16-gauge textured finish stainless-steel.
   6. Base:
      a. Stainless-steel with concealed ventilation cutouts.
   7. Finish Floor Covering:
      a. Furnished under other sections.
      b. Allow 5 lbs./ft^2 for floor weight.
      c. Service Cars 3/8" thick 3/8" epoxy terrazzo floor finish.
      d. Design for ease of replacement from within cab.
   8. Interior Wall Finish:
      a. Include allowance for interior car finishes.
   9. Ventilation:
      a. Morrison Products, Inc. two-speed model AA No. 06-01048 exhaust blower mounted to car canopy on isolated rubber grommets.
      b. Exhaust blower shall meet noise and vibration criteria.
   10. Lighting:
      a. Include allowance for lighting.
      b. Coordinate with emergency lighting requirements.
   11. Handrails/Guardrails:
      a. Include allowance for handrails and guard rails
   12. Pads and Buttons Permanently Mounted:
      a. Removable pads.
      b. Two pads covering side walls and adjacent front and rear returns.
      c. Provide cutouts to access main and auxiliary car operating panel and fire service panel.

2.13 HALL CONTROL STATIONS

A. Pushbuttons:
   1. Risers per groups:
      a. Cars 1 - 3: Provide two (2) hall control stations at each landing
      b. Cars 4 - 6: Provide two (2) hall control stations at each lobby.
         1) Front openings: Provide two (2) hall control stations at each landing
         2) Rear openings: Provide two (2) hall control stations at each landing
      c. Cars 7 - 8: Provide one (1) hall control station at each landing
         1) Provide two (2) additional hall stations to accommodate future travel
            a) Floor 03 – new intermediate hall control station
            b) Floor 04 – new upper terminal hall control station
      d. Cars 9 - 12: Provide two (2) hall control stations at each landing
   2. Provide flush mounted faceplates

a. Car 1 - 3 and Car 4-6 faceplates per architectural drawings, match elevator hoistway door frames and hoistway door finish. Architect to provide RAL color.
1) Refer to 2.5.G.

3. Include pushbuttons for each direction of travel that illuminate to indicate call registration.
a. Provide braille tags identified as “UP” and “DOWN” in each hall station.
4. Include approved engraved message and pictorial representation prohibiting use of elevator during fire or other emergency as part of faceplate.
5. Pushbutton design shall match car operating panel pushbuttons.
6. Provide vandal resistant pushbutton and light assemblies.
7. Provide LED illumination.
8. Provide Phase I Fire Service key switch, engraved operating instructions and illuminating jewel.
9. Provide communication check failure indication and silence key switch.
10. Provide illuminating jewels indicating standby power status.
11. Incorporate all items required by Code at the primary egress level into a single hall fixture.
12. Priority Service, Cars 4 – 6:
a. Hospital Emergency: Provide a means to activate hospital emergency service at each landing including rear openings where installed..
1) Coordinate activation means either key switch using Use 7-pin small format removable core or card reader.
2) Include engraving to identify feature.
13. Dual-Mode Operation, Cars 4 – 6
a. Incorporate Dual-Mode Operation. Refer to 2.6.I.
b. One (1) hall station at each landing to operate single car when Dual-Mode Operation II is selected by key switch.
c. One (1) hall station at each landing to operate remaining two (2) elevators as a group.
d. Incorporate key switch at main landing. Utilize a Use Yale 7-pin small format removable core. Engrave “Split Bank” with “on” and “off” labeled key positions.

B. Phase I Fire Service fixture:
1. Provide separate fixture including key switch, engraved operating instructions, and illuminating jewel.
2. Provide illuminating jewels indicating standby power status.
3. Include Car to Lobby Key Switches.

2.14 SIGNALS

A. Hall Direction Lantern, All Cars:
1. Provide at each entrance to indicate travel direction of arriving car.
2. Illuminate up or down LED lights and sound tone once for up and twice for down direction prior to car arrival at floor.
3. Illuminate light until the car doors start to close.
4. Sound level shall be adjustable from 20-80 dBA measured at 5'-0" in front of hall control station and 3'-0" off floor.
5. Provide advanced hall lantern notification to comply with ADA hall call notification time.
6. Provide adjustable car door dwell time to comply with ADA requirements relative to hall call notification time.
7. Hall direction lenses shall be arrow shaped with faceplates.
8. Lenses shall be minimum 2½" in their smallest dimension.
9. Locate as detailed on architectural drawings.
a. Cars 1 - 3: Provider vertical orientation located adjacent to hoistway door frame
b. Cars 4 - 6 Provider vertical orientation located adjacent to hoistway door frame

c. Cars 7 - 8: Provide horizontally orientated fixture located above hoistway door frame
d. Cars 9 - 12: Provide horizontally orientated fixture located above hoistway door frame.

B. Hall Position Indicator, All Cars:
1. Alpha-numeric digital indicator containing floor designations and direction arrows a minimum of 2½" high to indicate floor served and direction of car travel.
2. Mount integral with hall lanterns at all floors.
3. Provide vandal resistant indicator and light assemblies.

C. Car Position Indicator:
1. Alpha-numeric digital indicator containing floor designations and direction arrows a minimum of 2" high to indicate floor served and direction of car travel.
2. Locate fixture in car return panel above each car operating panel.
3. When a car leaves or passes a floor, illuminate indication representing position of car in hoistway.
4. Illuminate proper direction arrow to indicate direction of travel.

D. Fixture Faceplate Material and Finish:
1. Hall Lantern:
a. Cars 1 - 3, 4 - 6: Painted, RAL color provided by Architect
b. Cars 7 - 8, 9 - 10: Satin stainless-steel
2. Car Position Indicator: Satin stainless-steel
3. Hall Position Indicator:
a. Cars 1 - 3, 4 - 6: Painted, RAL color provided by Architect
b. Cars 7 - 8, 9 - 10: Satin stainless-steel
4. Hoistway Access Switch.
a. Cars 1 - 3, 4 - 6: Painted, RAL color provided by Architect
b. Cars 7 - 8, 9 - 10: Satin stainless-steel
5. Phase I Key Switch Faceplate.
a. Cars 1 - 3, 4 - 6: Painted, RAL color provided by Architect
b. Cars 7 - 8, 9 - 10: Satin stainless-steel
6. Custom Design: See architectural details.
7. Tamper resistant fasteners for all fastenings exposed to the public.

E. Voice Synthesizer:
1. Provide electronic device with easily reprogrammable message and female voice to announce car direction, floor, emergency exiting instructions, etc.

2.15 COMMUNICATION

A. Car Communication System:
1. Hands-Free Phone System:
a. Two-way communication instrument in car with automatic dialing, tracking, and recall features, with shielded wiring to car controller in machine room.
b. Provide dialer with automatic rollover capability with minimum two numbers:
1) Actuate two-way communication via “Help” button.
2) Adjacent light jewel shall illuminate and flash when call is acknowledged.
3) Button shall match car operating panel pushbutton design.
4) Provide “Help” button tactile symbol, engraved signage, and Tactile marking adjacent to button mounted integral with car front return panel.
c. The device shall consist of a single pushbutton, automatic dialer with appropriate indicator lights, and all other essential features necessary to comply with ADA.

d. The emergency phone shall be Ramtel model RR833-OEM and be mounted flush on the back of a hinged door at the bottom portion of the in-car control panel and locked with a barrel key #EX513.

e. The communication device shall be as manufactured by Ramtel model RR833-OEM to match the existing elevator emergency communication system including remote location indicator and other existing features now in use.

f. A stand-alone flush box-type device is not to be used without approval of the Owner.

g. The face plate shall have, including but not necessarily limited to:

EMERGENCY PHONE
UNIVERSITY OF KENTUCKY

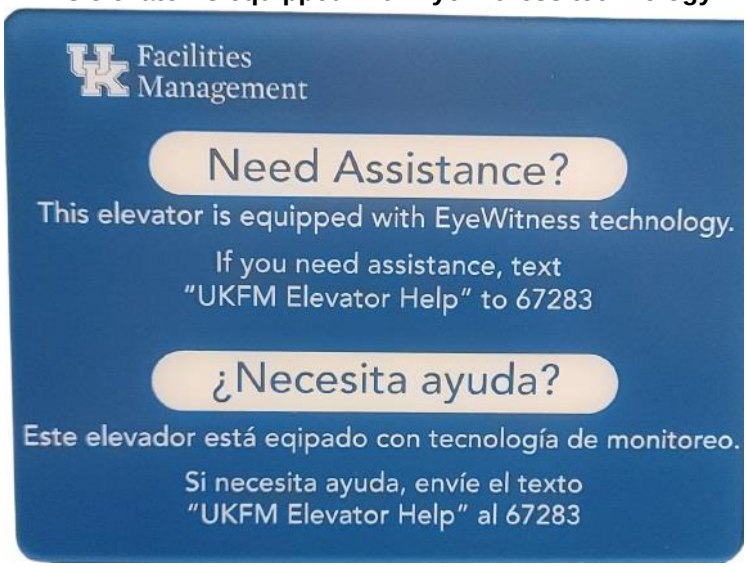
(include **UK** logo - Contact UK Public Relations for most recent logo updates)

Other information and instructions on the faceplate are as provided by the Ramtel communication device.

h. **RAVE Eyewitness Signage** should be included in every University of Kentucky owned elevator. The signs are 7.5 inches wide and 5.5 inches tall and should be installed at eye level as close to the emergency elevator call box as possible inside the elevator car. The signs are constructed from a hard plastic with quality 3M 467MP 200MP adhesive on the back. They should be UK Blue with white wording. The University Sign Shop has this on file and sample pictured below.

a. Wording should be as follows in both English and Spanish:

Need Assistance?
This elevator is equipped with EyeWitness technology.



If you need assistance, text
"UKFM Elevator Help" to 67283

Figure 1

2.

2. Emergency Personnel Communication:
   a. Communication system shall be provided allowing emergency personnel to establish communications with each elevator individually.

b. Emergency Personnel Communication shall override any existing connection outside of building.
c. Adjacent light jewel shall illuminate and flash when call is acknowledged.
d. Provide operating instructions.
e. On the same car operating panel as the phone push button, provide capability to communicate with and obtain responses from passengers.

3. Intercom System:
   a. General:
      1) Provide intercommunication system complete with talkback speaker, required auxiliary equipment and wiring.
      2) Include a preamplifier and associated equipment required to receive input from building.
      3) A battery backup system shall be provided for the two-way conversation system.
         a) The battery backup system shall be capable of providing power for a minimum of four (4) hours.
      4) If it is determined that there will not be a 24-hour manned station on the premises, then the system provided shall be capable of dialing out of the facility to a 24-hour manned answering service, or must be of the automatic dialing system and not an intercommunication system.
         a) In locations that call for Master Stations, a phone with a dedicated line shall be provided (by others).
   b. Master Stations:
      1) Fire Control Station
         a) Arrange to communicate with any other station, any group of stations or all stations simultaneously; include following devices:
            (1) Combination speaker-microphone.
            (2) Selector buttons for each station in system.
            (3) A button for simultaneous conversation with all stations in system.
            (4) Talk-listen button; press to talk, release to listen.
            (5) IN USE light to indicate when any master station is in use.
            (6) Reset Button; to disconnect call, extinguish in use light, and reset selection buttons to free system for next call.
            (7) Volume control.
      2) Machine Rooms:
         a) Arrange to communicate with other master stations and all elevator cars.
         b) In addition to devices specified for Fire Control Station, provide a loud audible signal to announce calls to this unit.
   c. Remote Stations:
      1) Provide combination speaker microphone in each elevator car as specified:
         a) Arrange to communicate with all master stations.

B. Elevator Management System and Information:
   1. General:
      a. Each controller shall provide an extensive list of output information, including data logging, fault logs operational events, performance information including car speed, floor to floor times, and door times.
      b. The system shall be real time, capable of driving remote monitors or computer terminal systems connected via Intranet system, that continually display the status of each car and call.
      c. Provide each group with a complete, interactive elevator monitoring system.
   2. The system shall concurrently display all units in a group and separate units on one screen in a graphical format and record the following information for each monitored unit:

a. Group status.
b. Individual car status with expandable menus.
c. Service Driven Outages.
d. Maintenance Activity Indicators.

3. Faults monitored with visual and audible alarm, triggered by combinations of any of the above status points. Transmit email when any monitored faults occur.
4. If out of service 15 minutes, initiate email to designated address. If fault continues more than eight hours, send email hourly until car returned to service.
5. Reporting Requirements:
   a. System shall provide reports in both tabular and graphical format, both on-screen and in printed form capability.
   b. Data for all reports shall be continuously recorded and stored.
   c. Reports shall be displayed by simply selecting a date and time range, bank of equipment, and report type.
   d. Date and time range selections shall carry forward from one report selection to the next.
   e. Reporting functions shall be sub-divided into the following categories:
      1) Traffic Reports.
      2) Fault Reports.
      3) Car Use Statistics.
      4) Group Service Log.
      5) Playback capability.

C. Service Account Interface Reporting:
1. Provide access to real-time data for elevators, including the following:
   a. Complete service history for all vertical transformation.
   b. Key performance indicators.
   c. Access to service request logs, disposition, and total downtime.
   d. Create service requests.
   e. View customer contracts.
   f. View and or accept Work Orders.
   g. Provide document repository.
2. Data shall be accessible from any device, including mobile.
3. Proper safeguards shall be confirmed, protecting clients from malware and virus receipt.

2.16 GROUP CONTROL AND FIREFIGHTERS' CONTROL PANEL

A. Elevator Control System, Cars 1 - 3, 4 - 6, 7 - 8, 9 - 12:
1. Provide a CPU and minimum 17" diagonal flat screen color monitor with the capability to activate, display, monitor, or control the following functions:
   a. On/off means to place car in or out of service.
      1) When placed in "off" position, return cars nonstop to designated floor and park with doors open for adjustable period of 1 to 3 minutes.
      2) At expiration of time, restore car to service.
   b. Car operating on normal/standby power.
   c. Car position and direction of travel.
   d. Car calls.
   e. Hall calls.
   f. Operating mode.
   g. Door status.
   h. Delayed car.
   i. Load weighing and by-pass.
   j. Car to lobby feature.
   k. Car in/out of service.
   l. Emergency power.

m. Firefighters' operation.
n. Alarm distress signal.
o. Card reader override.
p. Individual car on/off provisions.

2. Fixtures and monitor shall be located as directed by Contractor.
3. Where applicable, identify all indicators and manual switches with appropriate engraving.
4. Provide wiring and conduit to control panel.
   a. Coordinate size and location with Architect.

B. Firefighters' Control Panel:
1. Locate in building fire control room or as directed by Contractor.
2. Fixture faceplate, stainless-steel, satin finish, including the following features:
   a. Car position and direction indicator, digital-readout or LCD flat screen color monitor.
      1) Identify each position indicator with car number and group identification.
   b. Indicator showing operating status of car.
   c. Manual car standby power selection switches and power status indicators.
   d. Two-position firefighters' emergency return switches and indicators with engraved instructions filled red.
   e. Car to lobby key switches.
   f. Designate FSAE elevators.
   g. Dual mod Operation Key Switch, Cars 4 – 6.
   h. Master Station: Two-way communication inside service cabinet integral to control panel.
3. Where applicable, identify all indicators and manual switches with appropriate engraving.
4. Provide wiring and conduit to control panel.
   a. Coordinate size and location of conduit with Contractor.

C. Security Lobby Panel:
1. Locate in greater desk, as directed by Architect, refer to A201.A.
2. Fixture faceplate, stainless-steel, satin finish, including the following features:
   a. Car position and direction indicator, digital-readout or LCD flat screen color monitor.
      1) Identify each position indicator with car number and group identification.
   b. Indicator showing operating status of car.
   c. Car standby power status indicators.
   d. Two-position firefighters' emergency return switches and indicators with engraved instructions filled red.
   e. Designate FSAE elevators.
3. Where applicable, identify all indicators and manual switches with appropriate engraving.
4. Provide wiring and conduit to control panel.
   a. Coordinate size and location of conduit with Contractor.
5. Provide Car to Lobby key switches.
6. Provide the means in the Security Lobby Panel for automatic return to the primary landing.

D. Firefighters' Key Box: provide one (1) per group.
1. Flush-mounted box with lockable hinged cover.
2. Engrave instructions for use on cover per Local Fire Authority requirements.
3. Locate as directed by Architect at primary recall floor.

E. Machine Room Monitoring and Display System with Battery Backup:
1. Provide groups of elevators with a monitoring system in the Chief Engineer's office, or as directed by Architect, with color monitor.

2. System shall be a Windows based operating system capable of outputting to external media. As a minimum, system shall display the following functions:
   a. Car operating in normal/standby power.
   b. Car position and direction of travel.
   c. Car and hall calls.
   d. Operating mode.
   e. Door status.
   f. Delayed car.
   g. Load weighing and by-pass.
   h. Car to lobby feature.
   i. Car in/out of service.
   j. Emergency power.
   k. Firefighters' operation.
   l. Alarm distress signal.
   m. Card reader override.
      1) Individual car on/off provisions.
3. System Performance Monitoring:
   a. Hall call registration information:
      1) Provide memory capacity for at least the preceding five, 24-hour periods, in blocks of 5- or 15-minute segments, running hour to hour (i.e., 2:00 p.m. to 3:00 p.m.).
      2) Visual and printed summary of hall call registration events by floor, direction, and duration, totaled in 5- or 15-minute segments during any 60-minute block using an internal clock.
      3) Visual and printed summary of hall call registration duration averaged for 5- or 15-minute and hourly periods.
      4) Visual and printed summary of percentage of hall calls answered within 30 and 60 seconds in each 5- or 15-minute and hourly periods.
      5) Visual and printed summary of time periods during which individual cars are not in group operation (operating separately or out of service).
   b. Accumulate system fault data including nature of fault, time, and day.
   c. Store and retrieval capabilities for minimum 30-day period.
4. Provide printer to produce a hard copy of stored data.
5. Provide directions and software to accomplish information retrieval.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to beginning installation of equipment examine hoistway and machine room space areas.

B. Verify no irregularities exist that affect execution of work specified.

C. Verify electrical power location and characteristics in coordination with equipment requirements.

D. Do not proceed with installation until work in place conforms to project requirements.

3.2 INSTALLATION

A. Install all equipment in accordance with Contractor’s instructions, referenced codes, specification, and approved submittals.

B. Install machine room equipment with clearances in accordance with referenced codes and specification.

C. Install all equipment so it may be easily removed for maintenance and repair.

D. Provide any required hoisting/safety beams.

E. Install all equipment to afford maximum accessibility, safety, and continuity of operation.

F. Remove oil, grease, scale, and other foreign matter from the following equipment and apply one coat of field-applied machinery enamel.
   1. All exposed equipment and metal work installed as part of this work which does not have architectural finish.
   2. Machine room equipment, hoistway equipment including guide rails, guide rail brackets, and pit equipment.
   3. Neatly touch up damaged factory-painted surfaces with original paint color. Protect machine-finish surfaces against corrosion.

G. Fill hoistway door frames, back boxes for hallway stations and signal devices, and sills.

H. Clean all architectural finishes and replace or restore any surfaces damaged during construction to like new condition.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing:
   1. On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Operating Test:
   1. When emergency power is provided for the new elevator system, the elevators shall be tested under a full load on the generator. Include all emergency lighting and other emergency loads connected to the generator.
   2. Fireman’s Service shall be tested under emergency power conditions.
   3. Operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next.
   4. Record temperature rise of elevator machine during 30-minute test period.
   5. Record failure to perform as required.

C. Advise Contractor, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

D. Independent final installation review for conformance to construction documents by Owner’s Consultant.

3.4 CONSTRUCTION TOLERANCES

A. Install rails plumb and align vertically with tolerance of 1/16" in 100'-0".
   1. Secure joints without gaps and file any irregularities to a smooth surface.

3.5 ADJUSTING

A. Static balance car to equalize pressure of guide shoes on guide rails.
   1. Dynamically balance car and counterweight.

B. Lubricate all equipment in accordance with Contractor’s instructions.

C. Adjust motors, power conversion units, brakes, controllers, leveling switches, limit switches, stopping switches, door operators, interlocks, and safety devices to achieve specified performance levels.

3.6 CLEANING

A. Keep work areas orderly and free from debris during progress of project.

B. Remove packaging materials on a daily basis.

C. Remove all loose materials and filings resulting from work.

D. Clean machine room equipment and floor.

E. Clean hoistways, car, car enclosure, entrances, operating and signal fixtures.

F. Clean pit equipment and floor.

3.7 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate all aspects of elevators while in normal operation.

B. All non-propriety controls, tools, passwords, equipment, parts, and training necessary to service the elevator be provided to the University of Kentucky by the manufacturer and/or the Contractor.

C. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period.
   1. Determine that operation systems and devices are functioning properly.

3.8 PROTECTION

A. Temporary Use: 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.
      a. Include preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity.
      b. 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.
      a. Return items which cannot be refinished in the field to the shop, make required repairs, and refinish entire unit, or provide new units as required.

PART 4 - APPENDIX – TRIDIUM BUILDING AUTOMATION SYSTEM MONITORING POINTS

142000S02 ELEVATORS Appendix 1

APPENDIX 1			
Elevator Monitoring Tridium Minimum Points List – UK MCPPD			
Point List	**Point Type**	**Alarmable**	**Description**
Floor	ANALOG INPUT	NO	Current Floor Card is on or floor being called to
Controller Power	BINARY INPUT	YES	Power condition of controller
Controller Communications	BINARY INPUT	YES	Communication condition of controller
Up Direction	BINARY INPUT	NO	Travel Direction
Down Direction	BINARY INPUT	NO	Travel Direction
Door Open	BINARY INPUT	NO	Door Open Limit
Door Closed	BINARY INPUT	NO	Door Close Limit
In Normal Service	BINARY INPUT	NO	Service Condition
Inspection Service	BINARY INPUT	NO	Service Condition
Independent Service	BINARY INPUT	NO	Service Condition
Fire Service	BINARY INPUT	NO	Service Condition
Door Disabled	BINARY INPUT	YES	The doors appear to be disabled for use.
Emergency Power	BINARY INPUT	YES	Power condition of controller
Safety Circuit	BINARY INPUT	YES	An electrical contact wired in the main safety circuit is open. Car will not run. May be a temporary condition.
Door Fully Open and Locked at the Same Time	BINARY INPUT	YES	The doors appear to be locked and fully open simultaneously.
Bypass System Fault	BINARY INPUT	YES	Either the car door or hall door bypass switch (or circuit) has failed.
Door Lock Relay Fault	BINARY INPUT	YES	Either the car gate or the hall door relay (or input) has failed.
Door Zone Relay Fault	BINARY INPUT	YES	The door zone relay (or input) has failed)
Emergency Stop Relay Fault	BINARY INPUT	YES	Either the GTS or GTSX relay has failed.
Inspection Switch Fault	BINARY INPUT	YES	An Inspection switch or input has failed.
Level Relay Fault	BINARY INPUT	YES	The LVL relay has failed.
Stop Relay Fault	BINARY INPUT	YES	The STOP relay has failed.
Door Lock System Fault	BINARY INPUT	YES	Either the car gate or a hall door lock has been shunted.
Governor Contact System Fault	BINARY INPUT	YES	The overspeed governor has activated.
Front Door Limit System Fault	BINARY INPUT	YES	One of the two front door limit switches has failed in the open state.
Rear Door Limit System Fault	BINARY INPUT	YES	One of the two rear door limit switches has failed in the open state.
Contactor Drop System Fault	BINARY INPUT	YES	Contactor proofing fault (a monitored contactor did not drop as expected).
Unintended Movement System Fault	BINARY INPUT	YES	The car has left the floor with doors open.
Car Stop Bypass Relay Fault	BINARY INPUT	YES	The CSB relay has failed.
Drive Fault	BINARY INPUT	YES	The drive has declared a fault (or the DDRV relay has failed).
Down Relay Fault	BINARY INPUT	YES	The D relay has failed.
Up Relay Fault	BINARY INPUT	YES	The U relay has failed.

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Date: 3/2023
Applies to: All Projects
University of Kentucky

END OF SECTION

SECTION 200100 - GENERAL PROVISIONS - MECHANICAL

1. GENERAL

A. The Advertisement for Bids, Instructions to Bidders, Bidding Requirements, General, Special and Supplementary Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. All manufacturers, suppliers, fabricators, contractors, etc. submitting proposals to any part if for work, services, materials or equipment to be used on or applied to this project are hereby directed to familiarize themselves with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Proposer shall also be governed by any unit prices and Addenda insofar as they may affect his part of the work or services.

C. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical System(s) indicated or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor (or Construction Manager, if applicable), responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect (if applicable), then to the Engineer. Also, this section of the specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

F. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

G. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

H. Definitions and Abbreviations

(1) Contractor - Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of

mechanical work (Controls, Plumbing, HVAC, Sprinkler, Gas Systems, etc.) or, the General Contractor.

(2) Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.

(3) Architect - The Architect of Record for the project.

(4) Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

(5) Provide - Furnish and install complete, tested and ready for operation.

(6) Install - Receive and place in satisfactory operation.

(7) Indicated - Listed in the Specifications, shown on the Drawings or Addenda thereto.

(8) Typical - Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

(9) Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owners, etc.

(10) Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

(11) OSHA - Office of Safety and Health Administration.

(12) SBC - State Building Code.

(13) The Project - All of the work required under this Contract.

(14) NEC - National Electrical Code.

(15) NFPA - National Fire Protection Association.

(16) ASME - American Society of Mechanical Engineers.

(17) AGA - American Gas Association.

(18) SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

(19) ANSI - American National Standards Institute.

(20) ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers.

(21) NEMA - National Electrical Manufacturers Association.

(22) UL - Underwriters Laboratories.

(23) ADA - Americans with Disabilities Act.

(24) IMC - International Mechanical Code.

(25) IECC - International Energy Conservation Code.

(26) IFGC - International Fuel Gas Code.

I. Required Notices:

(1) Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

2. INTENT

A. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.

B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

3. DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The drawings are not intended to show every item which may be necessary to complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.

C. The drawings and specifications shall be considered to be cooperative and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.

F. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

G. Unless dimensioned, the mechanical drawings only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work.

H. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Landscaping, Structural, Surveys, etc., to ensure that the work he intends to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur, it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.

I. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

L. Special Note: Always check ceiling heights indicated on Architectural Drawings and Schedules and ensure that they may be maintained after all mechanical and electrical equipment is installed. Do not install equipment in the affected area until the conflict is resolved.

4. EXAMINATION OF SITE AND CONDITIONS

A. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His proposal shall cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests approval of materials and/or equipment of different physical size, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, electrical services, etc., from that indicated. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall remunerate them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.

B. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the provisions of Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineers.

D. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

6. SUPERVISION OF WORK

A. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act for him.

7. CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, water and/or sewer system development charge, etc. in connection with his work. He shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. He shall hire an independent Registered Engineer to witness installations and provide necessary certifications where required by utility companies, municipal agencies or others that have review authority. He shall also obtain all required certificates of inspection for his work and deliver same to the Engineers before request for acceptance and final payment for the work. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall also be versed in all Codes, Rules and Regulations pertinent to his part of the work prior to submission of a proposal.

B. The Contractor shall include in his work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

D. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable. Where required by the Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.

E. All plumbing work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such plans are in the hands of the Contractor.

F. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the local Building Code and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association. Contractor shall secure a permit from the Division of HVAC. Final inspection certificate shall be provided by Contractor and a copy included in Operation and Maintenance Manuals.

G. All pressure vessel installations shall comply with the State, and/or Federal Code applicable. A Certificate of Final Boiler Inspection shall be required.

H. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.

I. Where minimum code requirements are exceeded in the Design, the Design shall govern.

J. The Contractor shall ensure that his work is accomplished in accord with the OSHA Standards and that he conducts his work and the work of his personnel in accord with same.

K. The installation of all fuel storage tanks and associated piping, whether interior or exterior, shall be inspected by the State Fire Marshal, Hazardous Materials Section, before backfill. Submit certificate of this inspection to the Engineers.

L. Work in elevators, elevator shafts and elevator equipment rooms shall comply with the Elevator Code enforced by the local Building Code

M. All work relating to the handicapped shall be in accord with regulations currently enforced by the local Building Code and the American Disabilities Act.

N. All work in conjunction with a natural gas installation shall, in addition to all other Codes, Rules, Regulations, Standards, etc., comply with the requirements of the local gas supplier and/or standards and recommendations of the American Gas Association.

O. All work in relation to domestic water systems shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the requirements of the local water utility company and the adopted edition of the 10 States Standards.

P. All work in relation to the installation of sanitary or storm sewers shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the local agency governing such installations and the adopted edition of the 10 States Standards.

Q. All work relating to the handicapped shall be in accord with regulations currently enforced by the local Building Code and the American Disabilities Act.

R. The Contractor shall provide the services of a qualified third party independent inspector to perform all required special inspections required by local Building Code, as follows:

(1) Mechanical and Electrical Component Seismic Bracing per IBC 1705.

8. EQUIPMENT AND PIPING SUPPORT

A. Each piece of equipment, apparatus, piping, or conduit suspended from the structure or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

9. DUCT AND PIPE MOUNTING HEIGHTS

A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure.

10. COST BREAKDOWNS (SCHEDULE OF VALUES)

A. Within thirty days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.

11. CORRECTION PERIOD

A. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final

acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of his operator or other employees. Refer to other sections for any special or extra warranty requirements.

B. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.

C. All gas fired heat exchangers shall have 20-year warranty.

D. All compressors shall have five-year warranty.

12. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

13. CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

15. SURVEY, MEASUREMENTS AND GRADE

A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the contract documents, he shall promptly notify the Engineer and shall not proceed with this work until he has received instructions from the Engineer on the disposition of the work.

16. TEMPORARY USE OF EQUIPMENT

A. The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Engineers. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.

B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

C. A pre-start-up conference shall be held with the Architect, Owner, General Contractor and the Mechanical Contractor. Equipment shall not be started until after this meeting.

D. During all phases of construction:

(1) Air Handling Units:

a. At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.

b. On the outside of all return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the “construction” filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.

c. At substantial completion of the project the entire unit shall be cleaned to present a like “new” unit for the Owner and all filters shall be replaced with new.

E. The contractor shall be allowed to use the above-mentioned units and its associated ductwork provided the following conditions are met:

(1) The return air ductwork main shall be disconnected above the ceiling to utilize the space above the ceiling as a plenum. This shall prevent the return air ductwork from being used.

(2) Four sets of fiberglass filter media shall be installed at all of the inlets of each air handling unit. A differential pressure gauge shall be installed and the filter media shall be changed whenever a 1.0” wg pressure differential is present across the filter media. This shall be reviewed and recorded weekly by the contractor. The contractor is responsible for any temporary duct modifications as required to install the filter media.

(3) The MERV 14 final filters shall be installed prior to the start-up of the air handling units. These shall be replaced whenever a 1.5” wg pressure differential is present. This shall be reviewed and recorded weekly.

(4) The contractor shall replace all filter media with new and connect all ductwork to the units prior to the start of balancing any duct systems.

(5) Upon completion of the project the entire unit shall be cleaned to present a like “new” unit for the owner and all filters shall be replaced with new.

17. TEMPORARY SERVICES

A. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

18. RECORD DRAWINGS

A. The Contractor shall ensure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings, either hard copy of electronic pdf set aside at the job site especially for this purpose.

19. MATERIALS AND WORKMANSHIP

A. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes to furnish can be brought into the building(s) and installed within the space available. In certain cases, it may be necessary to remove and replace walls, floors and/or ceilings and this work shall be the responsibility of the Contractor. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.

B. Materials and equipment, where applicable, shall bear Underwriters' Laboratories label where such a standard has been established.

C. Use extreme care in the selection of equipment and its installation to ensure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.

D. Each length of pipe, fitting, trap, fixture and device used in the plumbing or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.

E. All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a data plate indicating required horsepower, voltage, phase and ampacity.

20. COOPERATION AND COORDINATION WITH OTHER TRADES

A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.

B. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1/4” = 1'-0”, clearly indicating how his work is to be installed in relation to the work

of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.

C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

21. QUALIFICATIONS OF WORKMEN

A. All mechanical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workman shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of Architect, Contractor, etc.

B. All plumbing work shall be accomplished by Journeymen Plumbers under the direct supervision of a Master Plumber as defined and clarified under State Plumbing Law Regulations and Code. Proof and Certification may be requested by the Engineer.

C. All sheet metal, insulation and pipe fitting work shall be installed by workmen normally engaged or employed in these respective trades, except where only small amounts of such work are required and are within the competency of workmen directly employed by the Contractor involved.

D. All automatic control systems shall be installed by workmen normally engaged or employed in this type work, except in the case of minor control requirements (residential type furnaces, packaged HVAC equipment with integral controls, etc.) in which case, if a competent workman is the employee of this Contractor, he may be utilized subject to review of his qualifications by the Engineer and after written approval from same.

E. All special systems (Pneumatic Tube, Oxygen, Vacuum, Medical Air, Automatic Sprinkler Equipment, etc.) shall be installed only by workmen normally engaged in such services. Exception to this specification may only be made in writing by the Engineer.

F. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

22. CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workman to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption of alcoholic beverages or other intoxicants, narcotics, barbiturates, hallucinogens or debilitating drugs on the job site is strictly forbidden.

23. PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a

means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at his own expense.

24. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

25. BROKEN LINES AND PROTECTION AGAINST FREEZING

A. No conduits, piping, troughs, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. If in doubt, contact the Engineer. Do not install piping across or near openings to the outside whether they are carrying static or moving fluids or not. Special Note: Insulation on piping does not necessarily ensure that freezing will not occur.

26. CLEANING

A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish and debris caused by his operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

27. CONCRETE WORK

A. The Contractor shall be finally responsible for the provisions of all concrete work required for the installation of any of his systems or equipment. He may, at his option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Mechanical work shall be 3000 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be set on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into floors to anchor pads.

B. All mechanical equipment (tanks, heaters, chillers, boilers, pumps, air handling units, etc.) shall be set on a minimum of 4” tall concrete pads. Pads shall be taller where required for condensate traps; confirm with cooling equipment submittal requirements. All concrete pads shall be complete with all

pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with ½" round bars on 6" centers both ways. Bars shall be approximately 3" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all square edges one-half inch.

C. In general, concrete pads for equipment shall extend six (6) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space.

D. Exterior concrete pads shall be four (4) inches minimum above grade and four (4) inches below grade on a tamped four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (1/2) inch chamfer on exposed edges.

E. All exterior below grade concrete structures (utility vaults, grease traps, manholes, etc.) shall be provided with exterior waterproofing. Waterproofing shall be hot-fluid applied rubberized-asphalt waterproofing membrane with elastomeric sheets at edges, corners, and terminations of membrane for continuous watertight construction. Apply in layers and reinforce as required to provide uniform seamless membrane minimum 4mm thickness. Also, seal penetrations into and out of the structure watertight. Provide Link-Seal modular seal or equal.

28. NOISE, VIBRATION OR OSCILLATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means. Unitary equipment, such as small room heating units, small exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineers.

29. ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.

B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, etc.

C. The Contractor shall provide access panels for each concealed valve, control damper or other device requiring service as shown on engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work.

30. RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, SURFACES, ETC.

A. The Contractor shall at his expense restore to their original conditions all paving, curbing, surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item and shall be to the satisfaction of the Architect and/or Engineer.

31. MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily.

B. Utilities and lines, where known, are indicated on the drawings. Locations and sizes are approximate. Prior to any excavation being performed, the Contractor shall ascertain that no utilities or lines are endangered by new excavation. Exercise extreme caution in all excavation work.

C. If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation or blasting in the respective area. Electromagnetic utility locators and acoustic pipe locators shall be utilized to determine where metallic and non-metallic piping is buried prior to any excavation.

D. Cutting into existing utilities and services where required shall be done in coordination with and only at times designated by the Owner of the utility.

E. The Contractor shall repair to the satisfaction of the Engineer, any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted with ten feet of electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only.

G. Protect all new or existing lines from damage by traffic, etc. during construction. Repairs or replacement of such damage shall be at the sole expense of the party responsible.

32. SMOKE AND FIRE PROOFING

A. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the Building Code. Patch all openings around ductwork and piping with appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at

fire walls, floors, ceilings, roofs, etc. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

33. MOTORS

A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with standards of A.S.A. C50, conforming to this and all applicable standards for insulation resistance and dielectric strength.

B. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box, and N.E.C. required disconnecting means as specified or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.

C. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 26 of Specifications for further requirements related to installation of motors.

34. CUTTING AND PATCHING

A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

35. CURBS, PLATES, ESCUTCHEONS & AIR TIGHT PENETRATIONS

A. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4-inch-high by 3-inch-wide concrete curb.

B. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

C. Seal all duct, pipe, conduit, etc., penetrations through walls and floors air tight. If wall or floor assembly is fire or smoke rated then the proper firestopping material and method shall be used to maintain the associated rating. Do not use firestopping for penetrations of non-rated assemblies.

36. WEATHERPROOFING

A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

37. OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

A. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list of representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.

B. The Contractor shall furnish three (3) complete bound sets for delivery to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract prior to substantial completion. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs alone will not be acceptable for operating and maintenance instructions.

C. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.

D. The Contractor shall frame under Lexan in the main mechanical room all temperature control diagrams and all piping diagrams.

38. PAINTING

A. In general, all finish painting shall be accomplished under the Painting Section of the specifications by the Contractor; however, unless otherwise specified under other sections of these specifications, the following items shall be painted:

(1) All exposed piping, valve bodies and fittings (bare and insulated), including hangers, platforms, etc.

(2) All mechanical equipment not factory finished. Aluminum and stainless-steel equipment, motors, identification plates, tags, etc. shall not be painted. All rust and foreign matter shall be thoroughly removed from surfaces prior to painting. All baked enamel factory finish of equipment which may have been scratched or chipped shall be touched up with the proper paint as recommended and supplied by the manufacturer.

(3) All ductwork exposed in finished areas (bare and insulated), all grilles, diffusers, etc. not factory finished. Paint the inside surfaces of all interior duct surfaces visible from any register, grille or diffuser opening on all jobs; surfaces shall receive one (1) prime coat of Rustoleum 1225 red "galvinoleum" or other approved equivalent primer and rust inhibitor and one (1) coat of Rustoleum 1579 jet black "Speedy Dry" enamel or approved equivalent applied in accordance with the manufacturer's recommendations.

(4) All insulated piping, ductwork and equipment shall be properly prepared for painting by the Contractor where mechanical items are to be painted. In the case of externally insulated duct

and pipe, the Contractor shall provide 6 oz. canvas jacket with fire retardant lagging. The jacket shall be allowed to dry properly before applying paint to avoid shrinking after painting and exposing unpainted surfaces. The Contractor, at his option, may provide double wall ductwork in lieu of externally insulated ductwork with canvas jacket and lagging.

39. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring thru starters, and shall furnish and install all required starters not factory mounted on equipment.

B. The Contractor shall, regardless of voltage, furnish and install all temperature control wiring and all associated interlock wiring, all equipment control wiring and conduit for the equipment that the Contractor furnishes. He may, at his option, employ at his own expense, the Electrical Contractor to accomplish this work.

C. After all circuits are energized and completed, the Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of the Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.

D. The Contractor shall furnish motor starters of the type and size required by the manufacturer for all equipment provided by him, where such starters are necessary. Starters shall have overloads for each phase.

40. FINAL CONNECTIONS TO EQUIPMENT

A. The Contractor shall finally connect to mechanical services, any terminal equipment, appliances, etc., provided under this and other divisions of the work. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer’s recommendations. If in doubt, contact the Engineers prior to installation.

41. REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost.

42. INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

43. HAZARDOUS MATERIALS

A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters

any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall ensure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

44. ABOVE-CEILING AND FINAL PUNCH LISTS

A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:

(1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.
(2) For review of all other work as the project nears substantial completion.

B. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.

C. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor at a rate of $140.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

Phone: 859 253-0892 Fax: 859 231-8357

The following is CMTA's guide for Division 20-25 required information relative to the Schedule of Values. Please utilize all items that pertain to this project and add any specialized system as required. A thorough and detailed schedule of values will allow for fair and equitable Pay Application approval and minimize any discrepancies as to the status of the job. For projects with multiple areas, provide a unique schedule of values for each independent area.

DIVISION 20-25 – MECHANICAL **Field Representative: _____**
Project Engineer: _____

Description of Work	Scheduled Value	Labor	Material
Shop Drawings			
Mobilization/Permits			
BIM Coordination			
Plumbing Underslab			
Sanitary Above Slab Rough-in			
Plumbing Fixtures			
Plumbing Inspections			
Sprinkler Plan Submittals			
Fire Protection Exterior			
Fire Protection Interior			
Storm Piping Exterior			
Storm Piping Interior			
Plumbing Shop Drawings			
Mechanical Shop Drawings			
Domestic Water Piping			
Domestic Water Insulation			

Hydronic Piping			
Gas Piping Exterior			
Gas Piping Interior			
Steam Piping			
HVAC Sheet Metal			
Steam Heat Exchangers			
Boilers			
Chillers			
Pumps & Assoc. Equipment			
Grilles & Diffusers			
Insulation			
Controls			
Air Balance			
Water Balance			
Chemical Treatment			
Boiler Inspection			
Factory Start-Up Reports			
Owner Training			
Record Drawings			
O & M Manuals			
Punchlist/Closeout			
Controls Check-out			

END OF SECTION 200100

SECTION 200200 - SCOPE OF THE MECHANICAL WORK

1. GENERAL

A. The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following:

(1) Complete exterior domestic water service finally connected to the local domestic water system.

(2) Complete exterior sanitary sewer system connected to the local system.

(3) Complete exterior storm drainage system.

(4) Complete exterior fire protection system.

(5) Interior domestic hot, cold and recirculating hot water system.

(6) Interior soil, waste and vent systems.

(7) Roof drainage system.

(8) All plumbing equipment, fixtures and fittings.

(9) 100% automatic sprinkler system.

(10) All mechanical exhaust systems.

(11) All insulation associated with mechanical systems.

(12) Condensate drainage systems.

(13) Complete heating, ventilation and air conditioning systems.

(14) Final connection of all mechanical equipment furnished by others (e.g., kitchen equipment).

(15) Complete balancing of air and water systems.

(16) Complete natural gas piping systems.

(17) All applicable services and work specified in Section 200100; General Provisions - Mechanical.

(18) All specified or required control work.

(19) Provide all required motor starters, etc. not provided under the electrical sections.

(20) One year guarantee of all mechanical equipment, materials and workmanship.

(21) Thorough instruction of the owner’s maintenance personnel in the operation and maintenance of all mechanical equipment.

(22) Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.

(23) Approved supervision of the mechanical work.

(24) Excavation, backfilling, cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.

(25) Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and shall include such requirements in his base bid.

(26) Procurement of all required permits and inspections, including fees for all permits and inspection services and submission of final certificates of inspection to the Engineers (Plumbing, Boiler, HVAC, etc.).

(27) All necessary coordination with gas, water, and sewer utility companies, etc., to ensure that work, connections, etc., that they are to provide is accomplished.

(28) Factory start-up of all major equipment (including terminal HVAC equipment) and submission of associated factory start-up reports to the Engineer.

END OF SECTION 200200

SECTION 200300 - SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS AND TOOLS

1. GENERAL

A. The Contractor's attention is directed also to the General and Special Conditions and Section 200100 - General Provisions - Mechanical as well as to all other Contract Documents as they may apply to his work.

B. The Contractor shall prepare and submit to the Engineer, through the General Contractor and the Architect (where applicable) within thirty (30) days after the date of the Contract, all shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter through **EComm.**

C. Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.

D. All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General Contractor and the Architect (if applicable) to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.

E. It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

F. The Engineers review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for: adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project. Any items that differ from the Drawings or Specifications shall be flagged by the Contractor so the Engineer will be sure to see the item. Do not rely on the Engineer to “catch” items that do not comply with the Drawings or Specifications. The Contractor is responsible for meeting the Drawings and Specification requirements, regardless of whether or not something does not get caught by the Contractor or Engineer during shop drawing reviews.

G. Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.

H. If the Contractor fails to comply with the requirements set forth above, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the drawings; and the Contractor shall be required to furnish all materials in accordance with this list.

I. Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors. Color samples shall be furnished with the shop drawing submission for such equipment.

J. Shop Drawing Submittals

(1) All submittals for HVAC equipment shall include all information specified. This shall include air and water pressure drops, RPM, noise data, face velocities, horsepower, voltage motor type, steel or aluminum construction, and all accessories clearly marked.

(2) All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule.

(3) All items submitted shall be designated with the same identifying tag as specified on each sheet.

(4) Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

2. SHOP DRAWINGS

Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

Air Handling Units
Chillers
Boilers
Fans
Steam Heat Exchangers
Steam Condensate Pumps
Fan Coil Units
Blower Coil Units
Hydronic Pumps
Fire Pump
Domestic Water Booster Pump
Fire Protection System
Duct Insulation
Pipe Insulation
Duct Materials
Piping Materials
Hydronic Specialties
Hydronic Chemical Treatment

SPECIAL NOTES:

1) Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) an electronic copy of operation and maintenance instructions and parts lists for each item marked (1) above. These documents shall include at least:

a. Detailed operating instructions
b. Detailed maintenance instructions including preventive maintenance schedules.

c. Addresses and phone numbers indicating where parts may be purchased.

2) Shop drawings for the Control Systems shall include detailed, scaled plans and schematic diagrams indicating the function and operation of the system.

3) Shop drawings for the Building Fire Protection System shall be prepared and stamped by a Certified Contractor and shall meet the criteria of the Department of Housing, Buildings and Construction and submitted to the Engineer. After the Engineer's review, they shall be submitted by the Contractor to the proper state authorities along with the required State review fee.

4) The Contractor shall submit to the Boiler Inspector's Office the required documentation and review fees for a boiler permit. The boiler permit shall be submitted to the Engineer along with the Boiler Shop Drawings.

5) The Contractor shall submit shop drawings for the kitchen hood system(s) along with all required supporting documentation and review fees to the Department of Housing, Buildings and Construction and receive approval prior to submittal to the Engineers.

6) The Contractor shall submit Material Safety Data sheets for all chemical treatment and anti-freeze solutions.

3. SPECIAL WRENCHES, TOOLS, ETC.

(1) The Contractor shall furnish, along with equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed under the Contract. Wrenches shall include necessary keys, handles and operators for valves, cocks, hydrants, etc. A reasonable number of each shall be furnished.

4. BALANCE REPORTS

A. Upon substantial completion of the project, the Contractor shall submit to the Engineers an electronic copy of the Certified Air and Hydronic Balance Report.

END OF SECTION 200300

SECTION 200500 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

   A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural and Structural drawings, to the end that complete coordination between trades will be affected. Special attention shall be given to the points where ducts or piping must cross other ducts or piping, where lighting fixtures must be recessed in ceilings, and where ducts, piping and conduit must fur into walls, soffits, columns, etc. It shall be the responsibility of the Contractor to leave the necessary room for other trades. No extra compensation will be allowed to cover the cost of removing piping, conduit, ducts, etc., or equipment found encroaching on space required by others.

   B. The Contractor shall be responsible for coordination with the Electrical trade to ensure that he has made provision for connections, operational switches, disconnect switches, fused disconnects, etc. for electrically operated equipment provided under this division of the specifications, or called for on the plans.

   C. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other Contracts, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of piping, ductwork, conduit, and equipment not installed in accordance with the above instructions, and which interfered with work and equipment of other trades.

   D. In all areas where air diffusers and lighting fixtures are to be installed, the Contractor shall coordinate their respective construction and installations so as to provide combined symmetrical arrangements.

2. INTERFACING

   The Contractor shall ensure that coordination is affected relative to interfacing of systems. Some interface points are (but not necessarily all):

   A. Connection of Domestic Water System to water service mains.

   B. Connection of Natural Gas System to natural gas service.

   C. Connection of Fire Protection System to domestic water service.

   D. Connection of Sanitary sewer house line to municipal service.

   E. Connection of Storm Drainage System to municipal system.

   F. Connection of fuel oil piping to emergency generator.

   G. Connection of Domestic Water System to Hydronic System.

   H. Connection of all controls to equipment.

   I. Electrical power connections to electrically operated (or controlled) equipment.

   J. Connection of Emergency Engine Exhaust System.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall make all connections to equipment furnished by others, or relocated from the existing structure, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. Supervision to assure proper functioning and operation shall be provided by the Contractor.

C. Items indicated on the drawings as rough-in only (RIO) will be connected by others. The Contractor shall be responsible for rough-in provisions only.

D. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

E. The Contractor shall be responsible for coordinating to determine any and all final connections that he is to make to equipment furnished by others.

4. COORDINATION DRAWINGS AND RECORD DRAWINGS

A. COORDINATION as follows:

(1) Detailed electronic coordination drawings shall be required for this project and shall be led by the Mechanical Contractor. A specific line-item shall be included on the schedule of values by each Trade for “preparation of coordination drawings”. The Engineer and the Engineer’s Field Inspector shall closely monitor progress and quality of the preparation of the electronic coordination drawings and may withhold pay requests as deemed appropriate.

(2) Coordination Drawings shall be provided on this project by each Trade (Mechanical, Fire Protection, Electrical). Drawings shall be 30 x 42 sheet size and shall be at ¼” scale and shall match the drawing setup as included in the Architectural Drawings. The Architect and Engineer will supply electronic drawings files of the Contract Documents upon the Contractor’s request and release.

(3) The basis for the Coordination Drawings shall be the sheet metal ductwork fabrication shop drawings and shall be prepared by the Mechanical Contractor. The Coordination Drawings shall indicate (1) systems above ceilings in finished areas, (2) systems supported from the structure in finished areas without ceilings, (3) systems in the mechanical rooms, and (4) all wall, roof, floor penetrations. **These drawings shall be 3-D drawings and shall be able to be reviewed with a 3-D software system such as Revit or Navisworks.**

(4) The sheet metal fabrication shop drawings shall be completed in a timely manner so as not to conflict with construction schedule and phasing plan. At the General Contractor’s discretion, these drawings shall be completed in phases to correspond with the project construction work sequencing. The Mechanical Contractor shall furnish an electronic copy of these ductwork shop drawings to all other Trades, specifically the Fire Protection and Electrical and other Contractors as requested by the General Contractor for the purpose of including other trades work on the Coordination Drawings.

(5) Pre-Coordination Meetings with all necessary trades shall occur. During these meetings, the Contractors shall discuss locations/elevations where piping, conduits, cable trays, etc.

will be installed with respect to the sheet metal fabrication drawings and other trades. The sheet metal ductwork and gravity piping systems shall be given the first priority. Within 30 days of the meeting, each Trade shall provide the Mechanical Contractor electronic drawings of all of their systems (with elevation noted), coordinated with the ductwork and other trades for them to incorporate into the Coordination Drawings. Coordination Meetings shall then occur so that all conflicts can be resolved between Trades. All conflicts shall be resolved between all Trades at these Coordination Meetings and the Mechanical Contractor shall then amend the Drawings to include the Final Coordinated Work.

(6) It is realized that not all systems can be completely detailed. The coordination drawings shall include the following at a minimum:

a. All ductwork including and all above ceiling equipment i.e. VAV boxes indicating appropriate maintenance access routed as indicated on the drawings. The drawings shall indicate a 3 ft. clearance zone that is unobstructed and allows access from a 2x2 ceiling tile.
b. All hydronic, plumbing, and sprinkler piping. Indicate all valves and ensure that appropriate access is provided for all valves.
c. Provide all conduits (existing or new) 2" and above. Multiple smaller conduits hung on a common trapeze hanger that is larger than 6" wide
d. All cable tray and enclosed wireway shall be indicated and shall indicate all required access.
e. All wall, roof, floor penetrations.

(7) After completion of the Final Coordination Drawings, a Final Review with the all Trades shall occur to provide any final comments and approval by all Trades. Other interim coordination meeting will be required to ensure successful coordination drawings. Any additional coordination items will be updated by the Mechanical Contractor. The Final Approved Coordination Drawings shall distributed electronically (on CD) to each Trade by the Mechanical Contractor. The Mechanical Contractor shall also furnish a complete 30x42 paper set of drawings to the jobsite main office and shall utilize them for updates of field conditions/deviations that occur during construction. Final Approved Coordination Drawings shall also be distributed to the General Contractor, Owner, Architect and Engineer for their Records. This process shall be completed prior to starting any work.

(8) RECORD DRAWINGS - Each Contractor shall ensure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on Coordination Drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Construction Manager, Owner, Architect and Engineer for their Records.

END OF SECTION 200500

SECTION 201100 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.

   C. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go through; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at is own expense.

   D. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

   E. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.

   F. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

2. SLEEVES, PLATES AND ESCUTCHEONS

   A. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for pipes where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the pipe or conduit and the sleeves shall be made completely and permanently water tight.

   B. Pipe that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

   C. At all other locations either pipe sleeves or core drilled openings are acceptable.

   D. Where thermal expansion does not occur, the wall may be sealed tight to the pipe or insulation.

E. Insulation, that requires a vapor barrier (i.e., cold water or refrigerant piping, etc.), must be continuous through the sleeve/cored hole. For other piping, insulation may stop on either side of the sleeve.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" above finished floor level.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

H. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4-inch-high by 3-inch-wide concrete curb.

I. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

3. CUTTING

A. All rectangular or special shaped openings in plaster, stucco or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.

B. Mechanical, plumbing, and fire protection contractors shall coordinate all openings in new and existing masonry walls with the General Contractor; and, unless otherwise indicated on the Architectural or Structural drawings, provide lintels for all openings required for the work (Louvers, wall boxes, exhaust fans, etc.). Lintels shall be sized as follows:

(1) New Openings under 48" in width: Provide one 3-1/2"x3-1/2"x3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.

(2) New Openings 48" to 96" in width: Provide one 3-1/2"x6"x3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.

(3) New Openings over 96" in width: Consult the Project Structural Engineer.

C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

4. PATCHING AND REPAIRING

A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or

damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.

C. Where the installation of conduit, ducts, piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

D. Where ducts penetrate fire rated assemblies, fire dampers shall be provided with an appropriate access door.

E. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.

F. Stainless steel collars shall be provided around all ducts, large pipes, etc., at all wall penetrations; both sides.

G. Where ducts, pipes, and conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to ensure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

H. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

END OF SECTION 201100

SECTION 201200 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall include all excavating, filling, grading, and related items required to complete his work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.

   C. Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2-0" to the side. Electric and fuel lines shall always be placed in a separate trench. All exterior lines shall have a minimum earth cover of thirty (30) inches to top of pipe, unless otherwise indicated.

   D. Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be encased for a distance not less than 5 feet on either side of the point of crossover.

2. SUBSURFACE DATA

   A. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavating to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating. This paragraph is written to include the removal of all rock with no extras, whether rock is indicated or not.

3. BENCH MARKS AND MONUMENTS

   A. Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

   A. Excavate trenches of sufficient width for proper installation of the work. When the depth of backfill over sewer pipe exceeds 10 feet, keep the trench at the level of the top of the pipe as narrow as practicable. Trench excavation for piping eight inches and smaller shall not exceed thirty-inch width for exterior lines and twenty-four-inch width for interior lines.

   B. Sheet and brace trenches as necessary to protect workmen and adjacent structures. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc., and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.

C. Rules and regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities discovered in the course of excavation shall be protected or relocated in accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineers. Machine excavation shall not be allowed within ten (10) feet of existing electric lines or lines carrying combustible materials. Use only hand tools.

D. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Engineer. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the Contractor's expense.

E. Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to ensure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell, or flange and/or is supported with blocks or wedges will not be accepted.

F. Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper jointing of pipe. Any water pumping from this Contractor's trenches which is required during construction, shall be included in this Contract.

G. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, large trees to remain, etc. The Contractors shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be borne by the responsible Contractor.

H. Use surveyor's level to establish elevations and grades.

I. The Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation of his work.

J. The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.

K. Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Mechanical Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

5. BACKFILL AND SURFACE REPAIR

A. Backfilling for mechanical work shall include all trenches, manhole pits, storage tank pits, and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.

B. Unless otherwise indicated or specified, all piping shall be bedded on four (4) inches minimum of compacted naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve on undisturbed soil excavated as described hereinbefore. Install tracer wire above pipe. Cover the pipe with twelve (12) inches of compacted backfill to prevent settlement above and around the new pipe. The backfill shall be naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. Prior to placing this second level of backfill, apply all required coatings and coverings to pipe, apply required tests and check the grading of the pipe to ensure that it is correct and that the pipe is free of swags, bows or bends. Also check lines for leaks at this point and repair as required. Once all of the preceding is accomplished, continue backfill with clean, debris and rock free earth tamped at six (6) inch intervals. Finish the backfill as specified following. Note: Water settling of backfill will be permitted only as an aid to mechanical compacting.

   (1) When installing any type of pipe below building footing, parallel or perpendicular to the footing, the area underneath the footing and in the zone of influence shall be backfilled with cementitious flowable fill. The zone of influence is the area within a 45-degree angle projecting down from the bottom edge of footers on all sides of the footing. Piping within flowable fill shall be isolated from the fill by a layer of heavy duty felt paper. Piping installed in trenches backfilled with flowable fill shall be anchored to the soil below prior to backfilling.

C. Backfill beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.

D. Backfill beneath paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill or unstable soil.

E. Backfill for natural gas lines shall be in strict accordance with the utility company or local municipalities requirements. If in doubt, contact the utility company or local municipality and/or the Engineer.

F. Backfill for lines carrying hazardous or combustible materials shall be in accordance with current codes, rules, regulations and safe practices. If in doubt, contact the Engineers.

G. Backfill for underground tanks shall be in accord with the tank manufacturer’s recommendations. If in doubt, contact the Engineers.

H. Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.

I. Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.

J. Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.

K. In the absence (if not specified or indicated elsewhere in the drawings or specifications to be done by others) of such work by others, the Contractor shall lay new sod over his excavation work. Level, compress and water in accord with sound sodding practice.

L. When running any type of piping below a footer or in the zone of influence the piping shall be backfilled with cementitious flowable fill. The zone of influence is the area under the footer within a 45-degree angle projecting down from the bottom edge of the footer on all sides of the footer. Additionally, grease traps, manholes, vaults, and other underground structures shall be held away from building walls far enough to be outside of the zone of influence.

M. Warning Tape and Tracer Wire

Provide a yellow and black plastic tape in all trenches 6" above the buried utility that identifies the utility about to be encountered. For non-metallic pipe a #12 copper wire shall also be laid in the trench to aid in future location of the piping. A foil faced warning tape may be used in lieu of the plastic tape and wire.

N. All manholes, vaults, and similar underground structures shall have the top elevation set flush with finished grade unless specifically noted otherwise.

6. MINIMUM DEPTHS OF BURY (TO TOP OF PIPE)

In the absence of other indication, the following shall be the minimum depth of bury of exterior utility lines. (Check drawings for variations).

A. Domestic Water Lines .....36 inches.

B. Fire Protection Lines.....42 inches.

C. Storm Lines .....20 inches.

D. Sanitary Lines (Exterior).....36 inches.

E. Natural Gas Lines.....36 inches.

F. Fuel Oil Lines.....36 inches.

G. Other lines carrying combustible and/or hazardous materials.....36 inches.

END OF SECTION 201200

SECTION 201300 - PIPE, PIPE FITTINGS AND PIPE SUPPORT

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineers. All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

C. All pipe shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted. Spacing of pipe supports shall not exceed eight feet for pipes up to 1-1/4 inches and ten feet on all other piping. Small vertical pipes (1 inch and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. (Refer to Specifications Section entitled INSULATION-MECHANICAL).

D. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation.

E. In general, piping shall be installed concealed except in Mechanical, Janitor Rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur, they shall be kept as close to walls as possible.

F. Installation of pipe shall be in such a manner as to provide complete drainage of the system toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be 1/2" size gate type with 3/4" hose thread end and vacuum breaker. Label each drain valve.

G. All hot and cold-water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.

H. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing; if in doubt, consult Engineer.

I. Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and sound practice.

J. All cast iron soil pipe and fittings shall be coated inside and out with coal tar varnish.

K. Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineers.

L. Nipples shall be of the same material, composition and weight classification as pipe with which installed.

M. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineers prior to submission of a bid proposal.

N. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If necessary, contact Engineers.

O. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case, shall be accomplished without use of insulating unions and permission of the Engineers.

P. Apply approved pipe dope (for service intended) to all male threaded joints. Pay particular attention to dope for fuel gas lines. The dope shall be listed for such use.

Q. High points of closed loop hot water heating systems shall have manual or automatic air vents as indicated or required unless automatic air vents are specifically indicated. Pipe to suitable drainage point.

R. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.

S. The entire domestic hot, cold and recirculating hot water piping system shall be sterilized in strict accord with requirements of the Department of Health Codes, Rules and Regulations for the State which the work is being accomplished in.

T. Provide expansion joints where shown on the plans and where required by good practice. Expansion joints shall be guided and anchored in accordance with the recommendations of the Expansion Joint Manufacturer's Association.

U. Where plastic pipe penetrates a fire rated assembly, it shall be replaced with a metal threaded adapter and a metal pipe per code.

V. Foam Core PVC is not permitted

W. Provide a fuel oil filter in front of the fuel oil pump as recommended by the pump and generator manufacturer.

X. Where piping penetrates interior or exterior walls, the wall shall be sealed airtight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

Y. Provide thrust blocks on all storm, sanitary, water, steam, hot, chilled, condenser, etc., and any other piping subject to hammering. Thrust blocks shall be provided at all turns.

Z. All piping to hydronic coils shall be full size all the way to the coil connection on the unit. If control valve is smaller than pipe size indicated, transition immediately before and after control valve. Also, if coil connection at unit is a different size than the branch pipe size indicated, provide transition at coil connection to unit. On 3-way valve applications, the coil bypass pipe shall be full size.

AA. Provide check valves on individual hot and cold-water supplies to each mixing valve (including each sensor style faucet, safety shower, mop sink, etc.) and each showerhead with a diverter valve (including all ADA showers). This requirement shall not be satisfied by mixing valves or fixtures with internal check valves. Independent external check valves are required.

2. UNIONS AND FLANGES AND WELDED TEES

A. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. Gaskets for steam piping systems shall be flexitalic spiral wound type. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

B. Dielectric insulating unions or couplings shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.

C. Tee connections for welded pipe shall be made up with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller.

D. All piping 2½" and larger shall use flanged joints in mechanical rooms.

3. SPECIFICATIONS STANDARDS

All piping and material shall be new, made in the United States and shall conform to the following minimum applicable standards:

A. Steel pipe; ASTM A-120, A-53 Grade A, A-53 Grade B.

B. Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.

C. Cast iron soil pipe; ASA A-40.l and CS 188-59.

D. Cast iron drainage fittings; ASA B16.12.

E. Cast iron screwed fittings; ASA B16.4.

F. Welding fittings; ASA B16.9.

G. Cast brass and wrought copper fittings; ASA B16.18.

H. Cast brass drainage fittings; ASA B16.23.

I. Reinforced concrete pipe; ASTM-C-76-64T.

J. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.

K. CPVC Plastic pipe; ASTM D2846.

L. PVC plastic pipe; ASTM D1785.

M. ABS plastic pipe; ASTM D1788-73.

N. High Density Polyethylene Pipe (HDPE); ASTM D12484

4. PITCH OF PIPING

All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

A. Interior Soil, Waste and Vent Piping:

1/4 inch per foot in direction of flow where possible but in no case less than 1/8" per foot.

B. Exterior Sanitary Lines:

Not less than one (1) percent fall in direction of flow and no greater than indicated.

C. Roof Leaders:

1/8 inch per foot where possible.

D. Condensate Drain Lines from Cooling Equipment:

Not less than 1/4 inch per foot in direction of flow.

E. High and Low-Pressure Steam Mains:

One inch in 20 feet in direction of flow.

F. Steam Condensate Return Lines:

One inch in 20 feet in direction of flow.

G. Exterior Storm Lines:

Not less than 1 percent grade in direction of flow.

H. All Other Lines:

Provide ample pitch to a low point to allow 100 percent drainage of the system.

5. APPLICATIONS

A. General Notes

(1) Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.

(2) Plastic piping or any materials with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.

(3) PVC, CPVC, or plastic piping shall not be used under paving, roads or areas where vehicular traffic is expected.

(4) PVC or plastic piping whether specifically listed or not may not be used in high rise buildings or anywhere else prohibited by code.

B. Sanitary Sewer – Exterior

(1) Service weight cast iron piping with bell and spigot fittings complying with ASTM A 74. All joints shall be compression gasket type.

C. Storm Sewer – Exterior

(1) Class II reinforced concrete pipe (RCP) with tongue and groove gasketed joints conforming to ASTM C-443.

(2) Service weight cast iron piping with bell and spigot fittings complying with ASTM A 74. All joints shall be compression gasket type.

D. Natural Gas Piping - Exterior

Exterior natural gas piping shall be thermoplastic gas pressure pipe with fittings complying with ASTM D 2513. All gas piping shall be installed per NFPA 54.

Columbia Gas requires, in compliance with Sections 192.283 and 192.285 of Title 49 of the Code of Federal Regulations, that Contractors installing plastic pipe be qualified in the procedures for joining plastic pipe. Contractors not previously qualified by Columbia should contact the local Columbia Gas office for information on the necessary procedures for qualifying under this requirement.

E. Domestic Water Piping - Exterior

(1) Type "K" hard copper with wrought copper fittings and brazed joints.

(2) Schedule 150 ductile iron piping with cement mortar lining and rubber gasketed joints.

F. Fire Protection - Exterior and Interior

Refer to the Fire Protection System section of these specifications.

G. Soil Waste and Vent Piping - General Requirements

(1) Water closet floor flanges and ells shall be cast iron regardless whether PVC piping is allowed or not.

H. Soil, Waste and Vent Piping (Below Slab)

(1) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the State Plumbing code.

(2) Waste piping serving Soda Machine drains, (floor sinks or floor drains) shall be: Service weight cast iron epoxy coated no-hub cast iron pipe and fittings, as manufactured by Newage Casting or approved equal. Certified to conform to ASTM A888 & CISPI 301. The two-part epoxy spray on coating shall have a 2.5 mil. Minimum exterior thickness and a 5 mil. Minimum interior thickness for adhesion and chemical resistance. Two-part epoxy is to be tested to be non- reactive from 2pH-12pH. Install piping in accordance to manufacturer's instructions. This branch piping shall run as this material until connected to the main.

(3) All sanitary piping below slab shall be service weight hubless cast iron with heavy duty bands. Bands shall be heavy duty with extra width for lateral support. Each coupling shall have a minimum of four bands. Cast iron will also be required at any other location where waste water temperature can exceed 120°F. Cast iron shall extend a minimum of 35' past last waste inlet..

I. Soil, Waste and Vent Piping (Above Slab)

(1) Service weight hubless cast iron pipe for all vertical sanitary waste and vent risers. Bands shall be heavy duty band with extra width for lateral support. Each coupling shall include a minimum of four bands. . Horizontal pipe and fittings 6” and larger, shall be suitably braced to prevent horizontal movement. Provide bracing in accordance to CIPI 301-00. Provide “Holdrite” bracing system or approved equal.

(2) All sanitary lateral and vent lateral piping shall be schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the State Plumbing code.

(3) All sanitary piping mains and branch piping above slab serving mechanical rooms drains, laundries and kitchens shall be service weight hubless cast iron with heavy duty bands. Bands shall be heavy duty with extra width for lateral support. Each coupling shall have a minimum of four bands. Cast iron will also be required at any other location where waste water temperature can exceed 120°F. Cast iron shall extend a minimum of 35' past last waste inlet..

J. Roof Leaders/Interior Storm Sewer Piping

(1) Service weight hubless cast iron pipe with manufacturers approved bands. Horizontal pipe and fittings 6” and larger, shall be suitably braced to prevent horizontal movement. Provide bracing in accordance to CIPI 301-00. Provide “Holdrite” bracing system or approved equal.

(2) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the State Plumbing code. All PVC piping installed above ceilings shall be provided with 1” insulation; refer to specification section 202200 for pipe insulation requirements.

K. Hydronic Piping (Heating Water, Baseboard Heating Water) - Underground

(1) General

a. Pre-insulated Piping
Furnish a complete system of factory pre-insulated steel piping for the specified service. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the pre-insulated piping system manufacturer. The system shall be Thermafab FERRO-THERM, Perma Pipe or Rovanco.

(2) Products

a. Carrier pipe shall be steel ASTM A-53, Grade B, ERW (Type E) or seamless (Type S), Standard weight for sizes 5" and larger, and shall be ASTM A-120/A-53, continuous weld (Type F), standard weight for sizes 4" and smaller. Seamless pipe smaller than 2" shall be ASTM A-106/A53, Grade B. All steel piping shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end for field joint fabrication.

b. Polyurethane foam insulation shall be injected with one shot into the annular space between carrier pipe and jacket with a minimum thickness of one inch. Insulation shall be rigid, 90-95% closed cell polyurethane with 2 to 3 pounds per cubic foot density and coefficient of thermal conductivity (K-factor) of 0.14 and shall conform to ASTM C-591. Maximum operating temperature shall not exceed 250 degrees F.

c. Jacketing material shall be extruded white polyvinyl chloride, consisting of clean, virgin NSF approved Class 12454-B PVC compound, conforming to ASTM D-1784, Type 1 Grade 1. PVC jacket shall have a wall thickness in mils equal to ten times the nominal jacket diameter and shall not be less than 60-mils. High density polyethylene (HDPE), conforming to ASTM D-1248, shall be used for jacketing larger than 20". Wall thickness for HDPE jacketing shall be 90-mils for sizes 8" and smaller, 100-mils for 10"-12", 150-mils for 14"-22", and 225-mils for 24" and larger. Jacketing for above ground, outdoors installations shall contain ultraviolet inhibitors for protection from sunlight. No FRP jacket allowed.

d. Straight run joints are insulated using urethane foam to the thickness specified, jacketed with PVC sleeves and sealed with polyethylene backed, pressure sensitive bituminous rubber tape, 30-mils thick. Above ground installations shall use white, pressure sensitive PVC tape.

e. Fittings are factory prefabricated and pre-insulated with urethane to the thickness specified, jacketed with a PVC fitting cover and then wrapped with polyethylene backed, pressure sensitive bituminous rubber tape, 30-mils thick. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded. Welds shall be radiographically inspected. At the Engineer's option, and for all above ground installations, fittings shall be jacketed using thermally butt-fused mitered sections of the same jacket material used on straight pipe sections. Fittings include expansion loops, elbows, tees, reducers and anchors. Fittings may be field insulated with liquid urethane foam insulation, jacketed with a PVC fitting cover and then wrapped with polyethylene backed, pressure sensitive bituminous rubber tape, 30-mils thick. Above ground installations shall use white, pressure sensitive PVC tape.

f. Expansion/contraction compensation will be accomplished utilizing factory prefabricated and pre-insulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for the intended application. External expansion compensation will be provided utilizing flexible expansion bolsters, extending three feet on either side, both inside and outside the radius of the fittings.

(3) Execution

a. Pre-engineered systems shall be provided with all straight pipe and fittings factory pre-insulated and prefabricated to job dimensions. Field engineered systems shall be provided with factory insulated straight pipe sections and factory prefabricated fittings, or field fabricated fittings insulated with kits provided by the system manufacturer.

b. Underground systems shall be buried in a trench of not less than three (3) feet deeper than the top of the pipe and not less than eighteen inches wider than the combined O.D. of all piping systems.

c. Trench bottom shall have a minimum of 6” of sand, fill material as a cushion for the piping. All field cutting of the pipe shall be performed in accordance with the manufacturer’s installation instructions.

d. A hydrostatic pressure test shall be performed at one and one-half times the normal system operation pressure for not less than two hours. Care shall be taken to ensure all trapped air is removed from the system prior to the test. Appropriate safety precautions shall be taken to guard against possible injury to personnel in the even of a failure.

e. Field service shall be provided by a certified manufacturer’s representative or company field service technician. The technician will be available at the job a minimum of three times to check unloading, storing, and handling of pipe, joint installation, pressure testing and backfilling techniques.

L. Sump Pump Discharge

(1) Type “M” copper with solder joints.

M. Natural Gas Piping – Interior

(1) Schedule 40 black steel pipe with 150 psi malleable iron threaded fittings for pipe sizes 2" and smaller.

(2) Schedule 40 black steel pipe with 175 psi wrought steel buttwelded fittings for pipe sizes 2-1/2" and larger.

(3) Where gas pressure is 5 psi or greater, piping shall be schedule 40 black steel pipe with wrought steel buttwelded fittings.

NOTES:

(1) All gas piping shall be installed per NFPA 54.

(2) Unions or valves shall not be installed in an air plenum.

(3) Piping below slab must be sleeved and vented.

(4) Piping installed in concealed locations shall not have mechanical joints.

N. Domestic Cold, Hot and Recirculating Hot Water Piping (Above Slab)

(1) Type "L" hard copper tubing with wrought copper fittings with lead free solder equivalent in performance to 95/5. (Maximum lead content of solder and flux is 2%).

(2) Victaulic 607 or engineer approved equivalent mechanical grooved pipe couplings and fittings may be used in lieu of solder. For potable water, product shall utilize grade “P” EPDM gasket rated from +0ºF to +180ºF for improved resistance to chlorine, chloramine and other typical potable water disinfectants. Victaulic 608N may be utilized with copper groove system.

O. Trap Primer Piping

(1) Above slab: It shall match domestic water piping requirements.

(2) Underslab: It shall match domestic water piping requirements with a protective sleeve.

P. Domestic Cold, Hot and Recirculating Hot Water Piping (Below Slab)

Type "K" hard or soft copper tubing with wrought copper fittings and brazed joints. There shall be no joints beneath slabs.

Q. Hydronic Hot Water Piping (Heating Water, Baseboard Heating Water)

(1) Less than 2”: Type "L" hard copper tubing with wrought copper fittings and 95/5 solder. Press-fit fittings are allowed in mechanical rooms only.

(2) 2” to 4”: Type “L” hard copper tubing with brazed joints and fittings. Press-fit or Victaulic fittings shall be allowed in mechanical rooms only. Refer to item (4) below for Victaulic fitting requirements.

(3) 6" and Larger: Schedule 40 black steel pipe with 150# welded. Weldolets may be used for branch line connections to pipe mains. Victaulic fittings shall be allowed in mechanical rooms only. Refer to item (4) below for Victaulic fitting requirements.

(4) Schedule 40 Victaulic 107V/W07 or engineer approved equivalent mechanical grooved pipe couplings and fittings with 125# rating minimum may be used. Housings cast with torque-absorber and shift-limiting slant bold pad design. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 250°F water temperature. Mechanical grooved piping may not be used if system water temperature exceeds 250°F.

a. Roll grooves in ends of pipe based on pipe and coupling manufacturer’s written instructions, which may or may not include torque settings, torque wrenches, extreme lubricant and specified gaps. Engineer reserves the right to inspect any and all installation of product. Factory trained representative must periodically visit the job site and provide on-site training. Grooved pipe shall be produced using approved

method by fitting manufacturer. Confirm all grooved pipe critical dimensions fall into the required tolerance range as listed by the tool manufacturer.

(5) Special Notes:

a. Dielectric unions shall be provided at all connections of dissimilar materials.

b. Victaulic and press-fit pipe fittings *for heating hot water* shall only be installed ~~*in accessible locations, i.e.*~~ in mechanical rooms~~*, above accessible lay-in ceilings, etc.*~~ These fittings shall not be installed above ~~*drywall*~~ ceilings, within walls, or within shafts.

c. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.

d. Takeoffs and branch piping to individual coils shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

R. Hydronic Chilled Water/Process Chilled Water Piping

(1) Less than 1.5": Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.

(2) 1.5" and Larger: Piping shall be high-density virgin polyethylene (HDPE) with a PE 4710 piping formulation and cell classification of 44576C for E per ASTM D 3350. All piping shall be SDR 9 with a minimum pressure rating of 250 psi.

(3) HDPE Piping shall be butt or socket fused in accordance with the manufacturer's instructions. The Contractor shall provide the Owner with one set of pipe fusing equipment, adequate to fuse all pipe sizes installed in the project. The Contractor shall provide the Owner with training on fusing techniques from the piping manufacturer.

(4) Victaulic HDPE piping system may be used in lieu of heat fusion joints for above ground HDPE applications. Contractor shall utilize Victaulic Style 905 HDPE Stab Couplings. Style 907 Transition Couplings may be used in conjunction with Vic-300/W761. Product shall be rated to pressures and temperatures exceeding the pipe. All grooved products must be of one manufacturer.

(5) Special Notes:

a. Dielectric unions shall be provided at all connections of dissimilar materials.

b. Where piping is within 10' of steam piping or steam condensate piping, piping 2-1/2" or larger shall be Schedule 40 black steel pipe with 250# welded or flanged joints. Weldolets may be used for branch line connections to pipe mains.

c. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.

d. Takeoffs and branch piping to individual coils shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.

S. Air Vent Discharge Lines

Type "L" soft copper; wrought copper fittings, 95/5 solder.

T. Steam and Condensate Return Piping

(1) 75 PSI - 150 PSI Steam Pressure: Steam and condensate return piping shall be Schedule 80 black steel pipe with 300 PSI fittings. All joints shall be welded or screw type. Screw fittings may be used for pipes 2" and smaller in size only. Welding neck flanges shall be used for connection to valves and flanged equipment. Weldolet and Threadolet fittings may be used for connecting branch pipe to mains where branch pipes are two pipe sizes smaller than the mains. Otherwise install welded tees.

(2) 1 PSI - 74 PSI Steam Pressure: Steam piping shall be Schedule 40 black steel with 150 PSI fittings. Condensate return piping shall be Schedule 80 black steel with 150 PSI fittings. All joints shall be welded or threaded screw type. Screw fittings may be used only for pipes 2" and smaller in size. Welding neck flanges shall be used for connection to valves and equipment. Threadolet or Weldolet fittings may be used for connecting branch pipes to mains where branch pipes are two pipe sizes smaller than the mains. Otherwise install welded tees.

(3) All gaskets for steam piping system flanged joints shall be flexitalic spiral wound type.

U. Low Pressure Steam Condensate

(1) 2” and smaller shall be Schedule 80 Black Steel with 300 lb. malleable iron, screwed fitting and 150 lb. screwed bronze gate valves. 2-1/2” and larger shall be Schedule 80 Black Steel with extra strong steel, welded with 150 lb. steel gate valves or 125 lb. flanged gate valves.

V. Condensate Drain Lines

(1) Type "DWV” copper, wrought copper, lead free solder.

W. Water Heater Relief Line

Type "M" copper tubing with sweat fittings and 95/5 solder.

X. LP Gas Piping

Same as specified for natural gas piping.

Y. Fuel Oil Suction, Return, Fill and Vent

(1) Interior – Standard weight black steel pipe with malleable iron screwed fitting.

(2) Exterior – Exterior fuel oil piping shall be Insul-tek Fiberclad Containment Piping. Approved equal manufacturers are Ric-Wil, Perma-Pipe and Thermacor. The Carrier pipe shall be dual pipe, standard weight steel pipe manufactured in accordance with ASTM A120A53, continuous weld. All pipe shall be cylindrical and straight, and ends shall be cut square, or beveled for welding.

(3) Carrier pipe fitting shall be steel socket weld fittings, in conformance with ANSI B31.1 and B16.11.

(4) Secondary containment pipe shall be steel, either electric resistance welded or spiral welded 10 gauge steel pipe, conforming to ASTM A211, A139, A135. All pipe shall be cylindrical and straight, and ends shall be cut square. Terminal sections shall be identical to straight sections except that they shall be fabricated with seals incorporating drain connections.

(5) Secondary containment pipe shall be protected by a totally corrosion-proof barrier of fiberglass reinforced plastic wound directly to the secondary containment pipe casing after it has been sand blasted to an SP-17 surface finish. The fiberglass reinforced plastic cladding shall be a minimum of 100 mils in thickness. Manufacturer's literature shall state that cathodic protection systems are not required due to the factory provided containment pipe coating, regardless of soil resistivity.

(6) Containment pipe fittings shall be factory fabricated from 10-gauge pipe with same fiberglass reinforced plastic coating as containment pipe and be fully compatible with the containment pipe material.

(7) Carrier pipe is to be centered and supported within containment pipe with centering devices. Centering devices are to be located not less than nine feet, or within twelve inches of the termination of the containment pipe on all fabricated pieces. Centering devices are to be so constructed as to allow free drainage of the system.

~~*Z. Engine Exhaust Piping*~~

~~*Schedule 40 black steel pipe with welded joints. Equipment connection shall be high temperature gasketed and flanged.*~~

AA. Acid Waste and Vent Piping - (Below Slab and Grade or Above Slab)

(1) Below slab: Schedule 40 non-flame retardant polypropylene pipe conforming to ASTM F1412 with joints made in accordance with the State Plumbing Code. Below grade piping shall be installed with fusion joint fittings.

(2) Above slab, pipe in non-plenum area: Schedule 40 flame retardant polypropylene pipe conforming to ASTM F1412 with joints made in accordance with the State Plumbing Code. Piping shall be installed with fusion joints within concealed spaces and with mechanical joints in accessible areas. All mechanical couplings below casework or exposed shall have the clamp edges smoothed or covered to keep sharp edges from cutting people.

(3) Piping shall be protected from sunlight in accordance with the manufacturer's recommendations.

(4) Acceptable manufacturers of acid waste and vent piping materials: Enfield (Ipex), Orion, or G.F. Sloane.

BB. Laboratory Deionized/RO Water Piping

Schedule 80 PVC pipe for pressure applications with solvent cement fittings. Pipe and fittings shall be manufactured from virgin rigid PVC vinyl compounds with a cell class of 12454 as identified in ASTM D-1748. Use caution to limit the amount of glue exposed to the interior of the piping. The system shall be flushed with a chlorine solution prior to activation of water purification system.

CC. Medical Gas Piping (Compressed Air Vacuum, Oxygen, Nitrogen and Nitrous Oxide)

Hard drawn, Type "L", pressure copper tubing conforming to ASTM B-88. Piping shall be factory washed and capped for medical gas service. Fittings shall be wrought copper, brazing type. Solder shall be brazing alloy with 1000°F melting point and suitable flux, Phoson Fifteen or Sil-Fos conforming to ASTM B-260.

END OF SECTION 201300

SECTION 201310 - WELDING

1. GENERAL

   A. All welding accomplished by the Contractor shall comply with provision of the latest revision of applicable codes, whether ASME Boiler and Pressure Vessel Code for pressure piping or such State and Local requirements as may supersede these codes.

   B. Welds shall be of sound metal thoroughly fused to the base metal at all points, free from cracks and reasonably free from oxidation blow holes and non-metallic inclusions. No fins or weld metal shall project within the pipe and should they occur they shall be removed. All pipe beveling shall be done by machine. The surface of all parts to be welded shall be thoroughly cleaned free from paints, oil, rust or scale at the time of welding, except that a light coat of oil may be used to preserve the beveled surfaces from rust.

   C. Pipe and fittings shall be carefully aligned with adjacent parts and this alignment must be preserved in a rigid manner during the process of welding.

   D. Each Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with specifications. If required by the Architect/Engineer, the Contractor shall cut out at least three (3) welds during the job for X-raying and testing. These welds shall be selected at random by the Resident Inspector and shall be tested as a part of the Contractor's Contract. Certifications of these tests and X-rays shall be submitted, in triplicate to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests.

2. WELDING QUALIFICATIONS

   A. It is required that all welding of piping covered by this specification, regardless of conditions of service, be installed as follows:

      (1) Pipe welding shall comply with the provisions of the latest revision of the applicable codes, whether ASME Boiler and Pressure Vessel Code, ASA Code for Pressure Piping, or such state or local requirements as may supercede codes mentioned above.

      (2) Before any pipe welding is performed, submit to the Owner or his authorized representative, a copy of the welding procedure specifications, together with proof of its qualification as outlined and required by the most recent issue of the code having jurisdiction.

      (3) Before any welder shall perform any pipe welding, submit to the Owner or his authorized agent the operator's qualification record in conformance with the provisions of the code having jurisdiction, showing that the operator was tested under the proven procedure specifications submitted.

      (4) Standard Procedure Specifications and Welders qualified by the National Certified Pipe Welding Bureau shall be considered as conforming to the requirements of these specifications.

      (5) “R” Stamp: Any welder performing modifications, repairs, etc. to boilers, pressure vessels, or other pressure retaining items shall have a current R stamp issued by the National Board of Boiler and Pressure Vessel Inspectors.

(6) “PP” Stamp: Any welder working with steam systems exceeding 15 PSIG shall have a current PP stamp issued by ASME. This shall apply up to the first stop valve for single boiler installations and up to the second stop valve for multiple boiler installations.

B. MATERIALS

(1) Welding fittings shall conform to ASA B16.9; of the same materials, thickness, etc., as the pipe being jointed; see ASA B36.10.

END OF SECTION 201310

SECTION 202100 - VALVES AND COCKS

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing cocks, air cocks, lubricated plug cocks, packed plug cocks, special valves for special systems, etc., for all Mechanical Systems.

   C. All valves shall be designed and rated for the service to which they are applied.

   D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.

   E. Ball valves with temperature and pressure ports are not an acceptable alternative to the balancing valves specified herein. Valves that do not comply with these specifications shall be removed and replaced by the Contractor with no increase in contract price.

   F. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts, Victaulic.

   G. All valves shall comply with current Federal, State and Local Codes.

   H. All valves shall be new and of first quality.

   I. All valves shall be full line size. Valves and hydronic specialties shall not be reduced to coil or equipment connection size. Size reductions shall be made at the connection to the equipment.

   J. Angle stops for plumbing fixtures shall be quarter turn ball type.

   K. All valves for use in potable water systems shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. LOCATION OF MAINTENANCE VALVES

   Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

   A. At each plumbing fixture.

   B. At each air handling unit, and make–up air unit.

   C. At each unit heater.

   D. At each heating or cooling coil.

E. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to ensure tightness against leakage for service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.

4. TYPES AND APPLICATION

A. GATE VALVES

Gate Valves shall be of the wedge disc type, permit straight line flow, complete shut-off and designed so that when the valve is wide open, it can be packed under pressure. Valves 1-1/2 inches and smaller shall be bronze, with ends to suit piping and non-rising stem. The valve shall have a deep stuffing box for long contact with the stem, packing gland and filled with high quality packing. Valves 2 inches thru 4 inches shall be iron body bronze mounted with flanged ends and non-rising stem. Boiler stop valves and valves larger than 4 inches shall be iron body bronze mounted flanged ends with outside screw and yoke with rising stem. Working pressure shall be 150 pounds when installed in piping with system pressures up to 150 pounds per square inch and 300 pounds for 250 pounds per square inch and over. 2" and under NIBCO T133, greater than 2" NIBCO F619. All gate valves 2” and smaller for use in potable water systems shall meet federal requirement to be lead free containing less than 0.25% lead by weight of wetted area. NIBCO F768B. Provide chain operator for all valves installed higher than 7’ above floor level.

B. GLOBE VALVES

Globe Valves shall permit control of flow rate from full flow to complete shut-off and designed that when the valve is wide open it can be repacked under pressure, and have a deep stuffing box with gland and filled with high quality packing. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping union bonnet, and with stainless steel plug type disc and seat of not less than 500 Brinnell hardness. Valves 2 inches and larger shall be iron body bronze mounted with flanged ends, yoke bonnet, and disc guide. Working pressure shall be 150 pounds when installed in piping with system pressures up to 150 pounds per square inch and 300 pounds for 250 pounds per square inch and over. 1-1/2" and under NIBCO T256AP, greater than 1-1/2" NIBCO F768B.

C. CHECK VALVES

Check Valves shall be horizontal swing type with two-piece hinges, disc construction seats to be bronze and bronze discs or with composition face depending on service and provide silent operation. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping, have full area "Y" pattern body and integral seats. Valves 2 inches and larger shall be iron body brass mounted and with flanged ends. Working pressure shall be 150 pounds when installed in piping with system pressures up to 150 pounds per square inch and 300 pounds for 250 pounds per square inch and over. 3" and under NIBCO T433Y, greater than 3" NIBCO F918B (for less than 100 psi systems) greater than 3” NIBCO F968B (for 100 psi or greater systems). Victaulic 716/779 check valves allowed with grooved piping system.

D. BALL VALVES (NON-POTABLE)

Ball Valves shall have removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blow out proof stem, full port, bronze body, reinforced Teflon seats, chrome plated steel ball as manufactured by Consolidated Valve Industries, Inc., Lunkenheimer, Apollo, Jenkins, Nibco or equivalent. Provide a stem extension so that the base of the handle is 1/4" above the insulation similar to Nibseal. NIBCO T5800-70.

E. BALL VALVES (POTABLE WATER)

All valves for use in potable water systems 2-1/2" and smaller contain less than 0.25% lead by weight and comply with federal lead free potable water requirements. Ball valves shall have a removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blowout proof stem, full port, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Apollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that they bas of the handle is ¼" above the insulation similar to Nibseal. NIBCO S-585-66-LF.

F. BUTTERFLY VALVES

Butterfly valves shall be line sized cast iron body, lug style, 200 PSI rating (bubble tight) EPT or Viton seat, cartridge type; high strength stem. Disc to have ground and polished seating surface. Operator shall be locking lever style. Quality equivalent to Crane Monarch series. 3" and under NIBCO LD3222-3, greater than 3" NIBCO LD322-5. Valves 6" and over shall have gear driven operators. 3" and under Victaulic 608N, greater than 3" Vic-300 butterfly valves allowed with grooved piping system. Butterfly valves to be used in domestic water supply shall be provided with stainless steel disc.

G. BALANCING VALVES

Bell & Gossett, Model CB circuit setter balancing valve or approved equivalent. Calibrated balancing valve shall have flanged connections suitable for 125# working pressure at 250°F. 4" and up shall be rated at 175# at 250°F working pressure. Provide with brass readout valves fitted with an integral EPT insert and check valve. Each balance valve shall have a calibrated nameplate to assure specific valve settings and be constructed with internal seals to prevent leakage.

H. AIR COCKS

Straight nose; Lunkenheimer Fig. 476; bronze; tee handle; bent nose; Lunkenheimer Fig. 478, 125#; bronze; tee handle.

I. GAUGE COCKS

Straight, Lunkenheimer, Fig. 1178; 125#; bronze; tee handle. FIP.

J. LUBRICATED PLUG COCKS

2" and under; Homestead Fig. 601; 150#; semi-steel; screwed; 2-1/2" and over; Homestead Fig. 602; ±50#; semi-steel; flanged.

K. PACKED PLUG COCKS

2" and under; DeZurik Fig. 425-S; 175#; semi-steel; screwed. 2-1/2" and over; DeZurik Fig. 425-F; 175#; semi-steel; flanged.

END OF SECTION 202100

SECTION 202110 - ACCESS TO VALVES, EQUIPMENT, FILTERS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. All mechanical equipment shall be installed in a manner which allows ready access to all components requiring service, adjustments, shutoff, etc.

   C. Filters shall be accessible, removable and replaceable without disconnecting mounting brackets, piping, wiring, etc.

   D. All oil cups, grease cups, grease fittings, etc. shall be accessible without disassembly of equipment, piping, ductwork, etc. (Extended oilers or grease fittings may be required).

   E. Provide access doors or panels for all equipment, valves, dampers, filters, fire dampers, etc. in concealed spaces not otherwise provided with suitable access. (Lay-in ceilings shall be considered acceptable access; splined or drywall ceilings shall not).

   F. All valves, unions, strainers, cleanouts, volume dampers, and test points shall be accessible.

   G. Access panels in lay-in ceilings shall be labeled with a lamacoid plate to indicate location of equipment, filters, valves, etc.

   H. Access panels in fire rated walls shall bear the same rating as the wall.

   I. Each fire damper shall be provided access through the duct to allow reset of the damper. This may be either a gasketed sheet metal panel over a suitable opening or a factory built access panel. The panel shall be at least one and one-half (12) inch larger than the opening all around and shall be held in place with sheet metal screws sufficiently to ensure that it is air tight. Manually check the size and location of each of these openings to ensure that the fire damper may be manually reset by use of hand only.

   J. Contractor shall coordinate the finish of all access doors and panels installed in finished areas with Architect.

2. ACCESS DOORS

   Refer to Sheet Metal and Flexible Duct section of the specifications.

END OF SECTION 202110

SECTION 202200 - INSULATION - MECHANICAL

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.

   C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

   A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

   A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.

   B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.

   C. All products and their packaging shall bear a label indicating above requirements are not exceeded.

   D. Duct linings shall meet the Erosion Test Method in compliance with UL Publication No. 181.

4. GENERAL APPLICATION REQUIREMENTS

   A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.

   B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork is to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No noticeable deformation of insulation or discontinuity of vapor seal, where required, will be accepted.

   C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, mechanical platform, mezzanine, penthouses, storage areas, unfinished rooms, etc. is to be considered as "exposed".

D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.

E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!

F. All insulation shall be installed with joints butted firmly together.

G. The Contractor shall ensure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

5. PIPING SYSTEMS

A. GENERAL

(1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.

(2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to ensure no condensation drip or collection.

(3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.

(4) Valves, flanges and unions shall only be insulated when installed on piping whose surface temperature will be at or below the dew point temperature of the ambient air.

(5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

(1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180-degree arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket. Approved manufacturers are listed in Section 2 – Manufacturers. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers' recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

(1) Domestic Cold Water, including trap primer piping above slab, Lab High Purity Water, Lab Deionized Water (KDMC Projects – all 1")

a. 1" piping – use 1/2" thick insulation. Provide an additional ½" layer of insulation 3" above and 3" below vertical pipe supports.

b. Pipe sizes 1-1/4" and above – use 1'' thick insulation.

(2) Hydronic System Fill Lines from Domestic Cold Water – 1" thick.

(3) Domestic 110°F Hot Water and 110°F Recirculating Hot Water. (If heat traced, see below)

a. Piping 2'' or less – use 1'' thick insulation.

b. Piping 2-1/2" to 4" – use 1-1/2" thick insulation

c. Piping 5'' or greater – use 2'' thick insulation.

(4) Domestic 140°F Hot Water and 140°F Recirculating Hot Water. (If heat traced, see below)

a. Piping 2'' or less – use 1'' thick insulation.

b. Piping 2-1/2" to 4" – use 1-1/2" thick insulation

c. Piping 5'' or greater – use 2'' thick insulation.

(5) Hydronic Hot Water

a. Piping 2'' or less – use 1'' thick insulation.

b. Piping 2-1/2" to 4" – use 1-1/2" thick insulation

c. Piping 5'' or greater – use 2'' thick insulation.

(6) Hydronic Chilled Water

a. 1" Piping – use 1" thick insulation

b. Piping 1-1/4" to 4" – use 1 ½'' thick insulation.

c. Piping 5" and larger - use 2" thick insulation.

(7) Horizontal Roof Leaders.

a. Piping 3'' or less – use 1/2" thick insulation

b. Piping 4'' or greater – use 1'' thick insulation

(8) Sanitary Sewer and plumbing fixture P-traps to waste stack – see schedule below. Insulate horizontal runs which receive air conditioning condensate and which are not located below slab or grade.

a. Piping 3'' or less – use 1/2" thick insulation

b. Piping 4'' or greater – use 1'' thick insulation

(9) Condensate Drain Lines.

a. Piping 1 ½'' or less – use 1/2" thick insulation

b. Piping 2'' or greater – use 1'' thick insulation

(10) High Pressure Steam and/or High Temperature Hot Water (306°F-450°F)

a.	1" and less pipe size:	1 ½" thick
b.	1 ¼" thru 1 ½" pipe size:	2" thick
c.	2" thru 4" pipe size:	3" thick
d.	5" and larger pipes:	3 ½" thick

(11) Medium Pressure Steam and Medium Temperature Hot Water (251°F-305°F)

a.	1" and less pipe size:	1 ½" thick
b.	1-1/4" thru 1-1/2" pipe size:	2" thick
c.	2" thru 4" pipe size:	3" thick
d.	5" and larger pipes:	3 ½" thick

(12) Low Pressure Steam (201°F-250°F)

a.	1 ½" or less pipe size:	1 ½" thick
b.	1 ½" and larger pipe sizes:	3" thick

(13) Steam Condensate

a.	1 ½" and less pipe size:	1 ½" thick
b.	2" and larger pipe size:	3" thick

D. ENGINE EXHAUST AND MUFFLER (INTERIOR ONLY)

(1) Rigid hydrous calcium silicate; K factor; .40 at 200°F mean temperature; 2" thick. Provide with a 6-oz. canvas jacket with fire retardant lagging.

E. STEAM/STEAM CONDENSATE & HOT WATER PIPING REMOVABLE JACKETING INSULATION

(1) All steam pressure reducing stations shall be installed with removable jacketing insulation to allow service to the station. This includes all fittings, valves, etc. on the steam pressure reducing stations. All steam condensate pumps shall be installed with removable jacketing insulation over reservoir. All steam traps 2 1/2" and larger shall have removable jacket insulation. All steam control valves shall be installed with removable jackets for maintenance.

Designer shall coordinate with UK on removable jackets required for HVAC hot water components such as large control valves or strainers.

(2) Insulation shall meet at minimum the following specification:

a) Non-Asbestos Glass mat, type E needled fiber.
b) Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
c) Jacket Material: Silicon/fiberglass compressed as required to give maximum 130F surface temperature depending on fluid medium in piping.
d) Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket.
e) Sewn lock stitch with a minimum 4 to 6 stitches per inch. The thread must be able to withstand the skin temperatures without degradation.
f) Hog rings, staples and wire are not are not acceptable methods of closure. Velcro straps alone are not acceptable unless written permission from UK (hook & loop method required).
g) No raw cut jacket edges shall be exposed.
h) Jackets shall be fastened using hook and loop (Velcro) straps
i) Provide a permanently attached Aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
j) The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
k) Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.
l) Insulation thickness: As required for Touch Temperature Exterior of all jacket < 130F.

F. MECHANICAL ROOM INSULATION

(1) Provide Calcium Silicate insulation in mechanical room heating applications, where piping is more subject to abuse. Insulation in mechanical areas must be protected with an 8-oz. canvas jacket applied with lagging adhesive.

CALCIUM SILICATE INSULATION APPLICATION AND THICKNESS (INCHES)						
PIPE SYSTEM	TEMP		PIPE DIAMETER (inches)			
	RANGE DEG F	1	1.25-2	2.5 – 6	8	10+
HIGH PRESS STEAM (-76 PSIG)	320 - 500	3.0	3.5	4.0	4.0	4.0
MED PRESS STEAM (21-75 PSIG)	260-320	2.5	3.0	3.5	4.0	4.0

(1) Insulate all surfaces not requiring constant access.

(2) Provide removable insulation for surfaces requiring periodic access.

(3) Insulate all surfaces creating a burn hazard.

(4) Exposed piping in any room and all piping in boiler or mechanical rooms shall have an 8-oz. canvas jacket applied over the fiberglass factory ASU/SSL jacketing to further protect the insulation from abuse. This jacketing must be properly applied with lagging adhesive, such that the outer surface is smooth and free of wrinkles. The canvas jacketing in all mechanical areas is to be prepared by painting, and then painted according to the University of Kentucky standard piping color coding. All chilled water piping insulation shall be completely sealed so that a perfect vapor barrier is achieved

G. JACKETS

(1) Exposed (Mechanical Rooms, Interior Finished Rooms and Storage Rooms)

All insulated piping installed in the above areas shall have a canvas or PVC jacket:

a. Exposed piping in any room and all piping in boiler or mechanical rooms shall have an 8-oz. canvas jacket applied over the fiberglass factory ASJ/SSL jacketing to further protect the insulation from abuse. This jacketing must be properly applied with lagging adhesive, such that the outer surface is smooth and free of wrinkles. The canvas jacketing in all mechanical areas is to be prepared for painting, and then painted according to the University of Kentucky standard piping color coding. All chilled water piping insulation shall be completely sealed so that a perfect vapor barrier is achieved

b. For all systems except steam, plenum rated PVC jacket equal to LoSmoke PVC jacket with flame/smoke rating of 25/50, ASTM-E84 test method. Minimum thickness 0.04 inches. Steam systems shall utilize plenum rated CPVC jacket with minimum thickness of 0.04 inches. Jackets shall be applied over top of specified pipe insulation. Approved equal manufacturers are Zeston and Speedline. Approved equal manufacturers are Zeston and Speedline.

(2) Exposed (Exterior)

In addition to the insulation specified for the exterior pipe, provide .016" aluminum jacket or PVC jacket 0.05” thick. The jackets shall be installed as recommended by the manufacturer to maintain water tight seal. All longitudinal and transverse seams to be sealed water tight. PVC jacket shall be Ceel-Co, Proto, or Zeston.

6. DUCTWORK SYSTEMS

A. GENERAL

(1) Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.

(2) Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to ensure no condensation drip or collection. The backs of all supply diffusers, plenums, grilles, etc. shall be insulated only if indicated by details on the drawings.

(3) Insulate the ends of slot diffuser plenum boxes.

(4) All flexible duct connections on insulated ductwork shall be externally insulated.

(5) All duct outside of building envelope, including rooftop duct, duct in unconditioned attic spaces above the insulation, etc. shall have two layers of specified insulation. This shall apply to supply air, exhaust air where air is run through energy recovery unit, outside air, return air, and combustion air intake ducts.

B. EXTERNAL INSULATION

(1) Supply Air
(2) Outside Air
(3) Relief Air
(4) Ducts from the exterior of the building to the backdraft or motorized damper
(5) Boiler Combustion Air
(6) Flexible Duct Connections on Internally Lined Ducts

Owens/Corning “Faced Duct Wrap - Type 100", or approved equal, 2" thick fiberglass duct wrap, 1.0 pcf density factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch. K factor shall not exceed .26 at 75°F. mean temperature. Minimum R-value of the 2” thick insulation shall be 7.4 out of package and 6.0 installed.

Special Notes:

a. Do not provide externally insulated duct per the above specification for any duct that is to be painted. Insulated duct that is to be painted shall be dual wall ductwork per specification Section 231200, Sheet Metal and Flexible Duct.
b. Where supply, return, and outside air ductwork is routed through an unconditioned attic or any other space outside of the building thermal envelope, the ductwork shall be provided with a minimum of 2 layers of duct wrap for a minimum R value of 11.0. Additionally, this shall apply to exhaust ductwork on entering side of energy recovery type air handling units.

C. EXTERNALLY INSULATED DUCT – OUTDOORS

(1) 2" semi-rigid fiberglass industrial board with foil scrim kraft vapor barrier facing or PSK Facing, 3.0 PCF density, K=.23 @ 75°F. Minimum R-value of 8.7. Owens/Corning, or approved equivalent industrial installation type 703. Weather proofing shall be ductmastic adhesive and sealer rated for outdoor use, Hardcast Flex-Grip 550, or approved equivalent.

(2) As an alternative to duct mastic adhesive and sealer, Contractor may provide a field applied aluminum jacket meeting the following specification:

Aluminum Jacket Material: Smooth finished sheets manufactured from 0.024-inch-thick aluminum alloy complying with ASTM B209 and having an integrally bonded 10mil thick, heat-bonded polyethylene and kraft paper moisture barrier over entire surface in contact with insulation.

Aluminum Jacket Applications: Apply aluminum jacketing to all external ductwork that is externally insulated. Cover all fittings and specialties with aluminum jacketing. Provide a 2-inch overlap at longitudinal seams and end joints. Secure jacket with stainless-steel sheet metal screws 6 inches o.c. and at end joints. Overlap longitudinal seams arranged to shed water and seal end joints with weatherproof mastic.

7. MECHANICAL EQUIPMENT

A. ROOF DRAIN SUMPS

(1) Owens-Corning Model 475-FR or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of .22 at 75°F. mean temperature. Insulation shall be 1" thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

B. FLOOR DRAIN SUMPS (Applies to all Floor Drains which Receive Air Conditioning Condensate and which are Installed in Locations Other Than Slab on Grade)

(1) Owens-Corning Model 475-FR or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of .22 at 75°F. mean temperature. Insulation shall be 1" thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

C. EXPANSION TANK, COMPRESSION TANK, AIR SEPARATOR, HEAT EXCHANGER, SIDESTREAM/LOOP FILTERS, AND HOT WATER STORAGE TANKS

(1) Owens-Corning "Tank Wrap I" or approved equivalent. Insulation shall be constructed of non-combustible, flexible wool. Insulation shall be 2" thick. K factor shall be .29 at 100°F. mean temperature. Insulation shall be attached in strict accordance with the manufacturer's recommendations. All insulation shall be jacketed with 6 oz. canvas with fire retardant lagging. Coordinate with mechanical contractor to extend all piping connections, blowdown ports, etc. outside of the insulation. Additionally, for loop filters and other equipment requiring periodic service, provide removable insulated covers.

END OF SECTION 202200

SECTION 202300 - THERMOMETERS AND OTHERS, MONITORING INSTRUMENTS

1. GENERAL

   A. The Contractor shall include all thermometers, pressure gauges and/or compound gauges at the locations indicated.

2. THERMOMETERS AND PRESSURE GAUGES

   A. All thermometers and gauges shall be readable from a standing position on the floor.

   B. Thermometers shall be linear, alcohol filled, graduated in 1°F. Or less and shall have adequate range for service intended.

   C. Pressure gauges shall be Bourdon Type, circular, 3" face, black letters on white face graduated in 2 PSI or less and shall have adequate range and shall be manufactured for service intended. Provide with pig tail connectors and gauge cocks.

   D. Pressure gauges and thermometers subject to vibration shall be mounted remotely away from vibrating pipe surface, etc., with flexible tubing.

   E. Mount thermometers in approved wells and install with thermal grease. Do not make direct contact of base with fluid in pipe.

   F. Gauges and thermometers shall be Marsh, Marshalltown, Weksler or equivalent.

3. Provide, when indicated on the plans, on the inlet and outlet of each terminal unit, a “Pete’s Plug” or equivalent pressure/temperature test station. Furnish two (2) matching thermometers and pressure gauges to the owner upon project completion.

END OF SECTION 202300

SECTION 202400 – IDENTIFICATIONS, TAGS, CHARTS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. VALVE TAGS AND CHARTS

   A. Provide and install on each valve in the Mechanical Systems a 1-1/2" diameter circular brass tag fitted to each valve so that it cannot be removed. Each tag shall be embossed consecutively with letter and number identifiers as to system and purpose respectively. Letter identifiers shall be as follows:

H	Heating
C	Cooling
HC	Combination Heating/Cooling
FP	Fire Protection
NG	Natural Gas

      Number identifiers shall be determined by the Contractor sequentially. For example, valve No. HC-1 may be maintenance stops for fan coil units. HC-2 maintenance stops for air heaters, etc.

   B. Provide three (3) copies of typewritten valve charts indicating each valve identifier, the valves purpose and its location. For example: "HC-1 Fan Coil Maintenance Stop-one valve at supply and return of each fan coil unit." One (1) copy of this chart shall be mounted in suitable wood frame(s) with clear plastic or glass covers in a conspicuous location in the Mechanical Room. Two other copies shall be turned over to the Engineers.

   C. Where more than one major Mechanical room is indicated for the project, install mounted valve schedule in each major Mechanical Room, and repeat only main valves which are to be operated in conjunction with operations of more than single Mechanical Room.

EQUIPMENT: COLOR:	ENGRAVES:
Valve Yellow	V.
Fire Damper Black	F.D.
Smoke Damper Black	SM.D.
Volume Damper Black	V.D.
Terminal Unit Red	T.

3. PIPING IDENTIFICATION

   A. GENERAL

      (1) Provide stenciled markers and arrows indicating direction of flow on all piping installed under this Contract. Markers and arrows shall be painted on the piping using machine cut stencils. All letters shall be sprayed using fast drying lacquer paint. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor. At the Contractor's option, Setmark or equivalent manufactured marking system may be substituted for field marking. The

following table describes the size of the color field and size of the identification letter which shall be used for pipes of different outside pipe diameters.

OUTSIDE DIAMETER OF PIPE OR COVERING	LENGTH OF COLOR FIELD	SIZE OF LETTERS
INCHES	INCHES	INCHES
3/4 TO 1-1/4	8	1/2
1-1/2 TO 2	8	3/4
2-1/2 TO 6	12	1-1/4
8 TO 10	24	2-1/2
OVER 10	32	3-1/2

(2) “Concealed”, where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. “Exposed” shall mean that piping or equipment is not “concealed” as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as “exposed”.

(3) All piping shall be marked not less than every 15 linear feet above a ceiling system, every 10 feet in a mechanical room, and at all points where lines pass through walls or floors.

(4) Provide pipe marker colors as indicated in the following table where manufactured marking systems are used:

University of Kentucky Standard Color Coding for Mechanical Piping Markers			
PIPE	ABBREVIATION	MARKER COLOR	NO.*
High Pressure steam and return (over 76 psig)	H.P.S. & H. P. R.	Safety Red	SW4081
Medium pressure steam and return (21 psig to 75 psig)	M.P.S. & M. P. R.	International Orange	SW4082
Low pressure steam and return (0 psig to 20 psig)	L.P.S. & L. P. R.	Safety Orange	SW4083
Domestic cold water	D.C.W.	Safety Green	SW4085
Domestic hot water	D.H.W.	Green Byte	SW4076
Medium temperature hot water & return (300F or less)	M.T.H.W. & M.T.H.W.R.	Safety Yellow	SW4084
Reheat supply & return	R.S. & R.R.	Junction Yellow	SW4033
Chilled water supply & return	C.W.S. & C. W. R.	Safety Blue	SW4086
Condenser water supply & return	C.D.W.S. & C.D.W.R	Slate Gray	SW4026
Natural gas	GAS	Deck Red	SW4040
Safety valve vents	S.V.V.	Galvano	SW4027
Cast iron soil & waste vents	W. & V.	Vacuum Black	SW4032

Chilled hot water	C.H.W.	Galvano	SW4027
Air (steel pipe)	AIR	Galvano	SW4027
Air (copper pipe)	AIR	None	--
Vacuum (copper pipe)	VAC	None	--
Vacuum (steel pipe)	VAC	Galvano	SW4027
Roof leaders	R. L.	Galvano	SW4027
Soft water	S.W.	Pillar White	SW4029
De-mineralized water	D.W.	None	--
Distilled water	DIST. W.	None	--
Diesel fuel	D. FUEL	Galvano	SW4027
Nitrogen	NITROGEN	Galvano	SW4027
Elevator oil lines	E.O.L.	Galvano	SW4027
Muriatic acid	MUR. ACID	Galvano	SW4027
Sulfuric acid	SUL. ACID	Galvano	SW4027
Chromate or cooling tower additives	C.T.A.	Galvano	SW4027
Boiler treatment	B.T.	Galvano	SW4027
Gasoline	GASOLINE	Galvano	SW4027
Nitrous oxide (copper)	N. OXIDE	None	--
Caustic soda	C. SODA	Galvano	SW4027
Condensate pump discharge	COND. P. D.	Galvano	SW4027
Sump pump discharge	S. PUMP DIS.	Galvano	SW4027
Oxygen	OXYGEN	None	--
Fire suppression/sprinkler system	FIRE	Safety Red	SW4081
Ammonia	AMMONIA	Bolt Brown	SW4001
Glycol solutions	GLYCOL	Rotor Turquoise	SW4066
Freon – R500	FREON R-500	Junction Yellow	SW4033
Freon – R502	FREON R-502	Recycled Red	SW4073

Notes: *Color and number are from the Sherwin Williams System 4000 color selection guide dated 1999.

A. Piping, whether exposed or concealed, shall be marked not less than every 15 linear feet and at the points where the piping passes through wall or floors.

B. In mechanical rooms, piping shall be labeled every 10 feet. (UK ONLY)

4. PIPE PAINTING (REFER ALSO TO ARCHITECTURAL SECTION ON PAINTING)

A. GENERAL

(1) Piping:
All plumbing and mechanical piping must be painted and labeled, including sprinkler lines, every 15 feet above a ceiling system and every 10 feet in an open mechanical room.

University of Kentucky Standard Color Coding for Mechanical Piping			
TYPE OF SERVICE	MARKINGS	COLOR	NO.*
High Pressure steam and return (over 76	H.P.S. & H. P. R.	Safety Red	SW4081

psig)			
Medium pressure steam and return (21 psig to 75 psig)	M.P.S. & M. P. R.	International Orange	SW4082
Low pressure steam and return (0 psig to 20 psig)	L.P.S. & L. P. R.	Safety Orange	SW4083
Domestic cold water	D.C.W.	Safety Green	SW4085
Domestic hot water	D.H.W.	Green Byte	SW4076
Medium temperature hot water & return (300F or less)	M.T.H.W. & M.T.H.W.R.	Safety Yellow	SW4084
Reheat supply & return	R.S. & R.R.	Junction Yellow	SW4033
Chilled water supply & return	C.W.S. & C. W. R.	Safety Blue	SW4086
Condenser water supply & return	C.D.W.S. & C.D.W.R	Slate Gray	SW4026
Natural gas	GAS	Deck Red	SW4040
Safety valve vents	S.V.V.	Galvano	SW4027
Cast iron soil & waste vents	W. & V.	Vacuum Black	SW4032
Chilled hot water	C.H.W.	Galvano	SW4027
Air (steel pipe)	AIR	Galvano	SW4027
Air (copper pipe)	AIR	None	--
Vacuum (copper pipe)	VAC	None	--
Vacuum (steel pipe)	VAC	Galvano	SW4027
Roof leaders	R. L.	Galvano	SW4027
Soft water	S.W.	Pillar White	SW4029
De-mineralized water	D.W.	None	--
Distilled water	DIST. W.	None	--
Diesel fuel	D. FUEL	Galvano	SW4027
Nitrogen	NITROGEN	Galvano	SW4027
Elevator oil lines	E.O.L.	Galvano	SW4027
Muriatic acid	MUR. ACID	Galvano	SW4027
Sulfuric acid	SUL. ACID	Galvano	SW4027
Chromate or cooling tower additives	C.T.A.	Galvano	SW4027
Boiler treatment	B.T.	Galvano	SW4027
Gasoline	GASOLINE	Galvano	SW4027
Nitrous oxide (copper)	N. OXIDE	None	--
Caustic soda	C. SODA	Galvano	SW4027
Condensate pump discharge	COND. P. D.	Galvano	SW4027
Sump pump discharge	S. PUMP DIS.	Galvano	SW4027
Oxygen	OXYGEN	None	--
Fire suppression/sprinkler system	FIRE	Safety Red	SW4081
Ammonia	AMMONIA	Bolt Brown	SW4001
Glycol solutions	GLYCOL	Rotor Turquoise	SW4066

Freon – R500	FREON R-500	Junction Yellow	SW4033
Freon – R502	FREON R-502	Recycled Red	SW4073

Notes: *Color and number are from the Sherwin Williams System 4000 color selection guide dated 1999.

A. Water heaters, storage tanks, heat exchangers, etc., shall be painted light gray.

B. Piping, whether exposed or concealed, shall be marked not less than every 15 linear feet and at the points where the piping passes through wall or floors.

C. In mechanical rooms, piping shall be labeled every 10 feet. (UK ONLY)

5. EQUIPMENT IDENTIFICATION

A. All equipment, except in finished rooms, shall be identified by stenciling the title of the equipment as taken from the plans in a position that is clearly visible from the floor. The letters shall be made with black paint and shall be not less than two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. Lamacoid plates are also acceptable. In finished rooms or outdoors, equipment shall be identified by engraved nameplates.

6. DUCTWORK IDENTIFICATION

A. All ductwork shall be identified as to the service of the duct and direction of flow. The letters shall be at least two inches high and the flow arrow shall be at least six inches long. The letters and flow arrow shall be made by precut stencils and black oil base paint with aerosol can. Concealed ducts need not be identified.

7. ACCESS THROUGH LAY-IN CEILINGS

A. Mark the ceiling T-bar nearest the ceiling panel access to equipment, valves, damper, filter, duct heaters, etc., with a small red lamacoid plate with name of item above ceiling.

END OF SECTION 202400

SECTION 202500 - HANGERS, CLAMPS, ATTACHMENTS, ETC.

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. Each Contractor's attention is also directed to Section 201300, Pipe, Pipe Fittings and Pipe Support.

   C. This section includes, but is not limited to, furnishing and installing dampers, supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work.

   D. Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

2. MATERIALS AND EQUIPMENT

   A. Hangers, Clamps, Attachments, Etc.:

	SIZE	SPECIFICATION
1. Pipe Rings	2" pipe and smaller	Adjustable swivel split ring or split pipe ring, Grinnell Figures 104 and 108, Elcen, Fee & Mason, or approved equivalent.
2. Pipe Clevis	2-1/2" pipe and larger	Adjustable wrought Clevis type, Grinnell Figure 260, Elcen, Fee & Mason, or approved equivalent.
3. Pipe Clevis	All	Steel Clevis for insulated pipe, Elcen Figure 12A, Grinnell, Fee & Mason or approved equivalent.
4. Rise Clamps	All	Extension pipe or riser clamp, Grinnell Figure 261, Elcen, Fee & Mason or approved equivalent.
5. Beam Clamps and Attachments	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason, or approved equivalent. Malleable beam clamp with extension piece figure 229; I-beam clamp figure 131; C-clamp figures 83, 84, 85, 86, 87, and 88.
6. Brackets	All	Welded steel brackets medium weight, Grinnell Figure 195, Elcen, Fee & Mason or approved equivalent.
7. Concrete Inserts	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason or approved equivalent. Wrought steel insert Figure 280 and wedge

		type insert Figure 281.
8. Concrete Fasteners	All	Self-drilling concrete inserts, Phillips, Grinnell, Elcen or approved equivalent.
9. Ceiling	All	Grinnell Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Pipe hanger flange Figure 153, adjustable swinging hanger flange Figure 155, ceiling flanges Figures 128 and 128R, and adjustable ceiling flange Figure 116.
10. Rod Attachments	All	Grinnell Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Extension piece Figure 157, rod coupling Figure 136, and forged steel turnbuckle Figure 230.
11. U-Bolts	All	Standard, U-bolt, Grinnell Figure 137, Elcen, Fee & Mason, or approved equivalent.
12. Welded Pipe Saddles	All	Pipe covering protection saddle sized for thickness of insulation, Grinnell Figure 186, Elcen, Fee & Mason or approved equivalent.
13. Pipe Roll	All	Adjustable swivel pipe roll, Grinnell Figure 174, Elcen, Fee & Mason, or approved equivalent.
14. Protection Saddle	All	18-gauge sheet metal pipe protection saddle, Elcen Figure 219, Fee & Mason, Power Strut, or approved equivalent.
15. Hanger Rods	All	Steel, diameter of the hanger threading, ASTM A-107.
16. Miscellaneous Steel	All	Steel angles, rods, bars, channels, etc., used in framing for supports and fabricated brackets, anchors, etc., shall conform to ASTM-A-7.
17. Concrete Channel Inserts	All	Continuous slot inserts, Unistrut, or approved equivalent. Heavy duty Series P-3200 or Light Duty Series P-3300 as required.
18. Adjustable Spot Insert	All	Adjustable spot insert Unistrut, or approved equivalent, P-3245. Design load 1000 lbs.

3. INSTALLATION

A. Unless otherwise specifically indicated or hereinafter specified in the specifications, all supporting, hanging and anchoring of piping, ductwork, equipment, etc., shall be done by each trade as is necessary for completion of the work and shall be as directed in the following paragraphs:

(1) Supporting and hanging shall be done so that excessive load will not be placed on any one hangers so as to allow for proper pitch and expansion of piping. Hangers and supports shall be placed as near as possible to joints, turns and branches.

(2) For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power-driven devices may be used when approved in writing by the Architect/Engineer. Utilize beam clamps for fastening to steel joists and beams and expansion anchors in masonry construction. When piping is run in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger.

(3) Trapeze hangers shall be supported by steel rods of sufficient diameter to support piping from joists or concrete construction. Where desired or required, piping may be double mounted on trapeze hangers. Where conditions permit, trapeze hangers may be surface mounted on exposed joists by means of approved beam clamps, or to concrete construction by means of approved adjustable inserts or expansion anchors.

(4) Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross steel joists.

(5) Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.

(6) Where piping, etc., is run vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum and an approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.

(7) Where piping is run along walls, knee braced angle frames or pipe brackets with saddles, clamps, and rollers (where required) mounted on structural brackets fastened to walls or columns shall be used.

(8) Support all ceiling hung equipment, with approved vibration isolators.

(9) Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.

(10) Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze and wall bracket type support shall be held in place with U-bolts. U-bolts shall allow for axial movement in the piping.

(11) All insulated piping shall be supported with clevis type and/or pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.

(12) Under no conditions will perforated band iron or steel wire driven hangers be permitted.

(13) In general, support piping at the following spacing:

a. Steel and copper piping - 5 feet intervals for piping 3/4" and smaller. 6 feet intervals for 1 ¼" and 1" pipe. 8-foot intervals for piping 1 ½" to 3". 10-foot intervals piping 3 ½" and larger.

b. PVC/HDPE piping – 4-foot intervals for piping 1 1/2" and smaller. 5-foot intervals for 2 and 2 ½" piping. 6-foot intervals for 3" pipe and larger.

c. Where the manufacturer of the pipe has more strict guidelines, the manufacturer's recommendations shall be followed.

END OF SECTION 202500

SECTION 202600 – MECHANICAL/ELECTRICAL VIBRATION CONTROLS

1. GENERAL

A. RELATED DOCUMENTS

(1) Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and Division 1 Specifications Sections, apply to this section.

B. MANUFACTURERS

(1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:

Mason Industries
Vibration Eliminator Co., Inc.
Vibration Isolation Co., Inc.
Kinetics Noise Control
Vibration Management Corporation - Vimco

All Seismic restraint devices; isolators, calculations and seismic design shall be provided by a single vibration isolator manufacturer as listed above.

C. SUMMARY

(1) This Section includes vibration isolators, vibration isolation bases, and seismic restraints and snubbers for mechanical and electrical equipment, duct and piping systems.

Drawings and calculation
Certification of seismic restraint designs
Installation supervision

D. PROJECT CONDITIONS

(1) Building Classification Category is III (2018 KBC – Table 1604.5).

(2) Seismic Design Category: A

(3) Component Importance Factor is 1.0 for all Mechanical and Electrical Systems

a. The interrelationship of components and their effect on each other shall be considered so that the failure of any essential or non-essential architectural, mechanical or electrical component shall not cause the failure of another essential architectural, mechanical or electrical component.

(4) Duct restraints are not required if conditions of ASCE 7-05; Chapter 13 paragraph 13.6.7 are met.

(5) Piping restraints are not required if conditions of ASCE 7-05; Chapter 13; paragraph 13.6.8 are met.

(6) Fire Protection Sprinkler Systems: Refer to ASCE 7-05; Chapter 13, paragraph 13.6.8.2 and 13.6.8.3.

E. APPLICABLE CODES AND STANDARDS

(1) The Kentucky Building Code; 2013; Chapter 16, 17

(2) ASCE 7-05, Chapter 13.

F. SUBMITTALS

(1) Product Data: Indicate types, styles, materials, and finishes for each type of isolator and seismic restraint specified. Include load deflection curves.

(2) Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.

1. PRODUCTS

A. VIBRATION ISOLATORS

(1) Rubber Isolator Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top-and baseplates. Factory drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range.

(2) Restraint Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.

(3) Housing: Welded steel or ductile iron. Factory-drilled baseplate for bolting to structure and bonded to a 1/4 –inch-(6mm) thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.

(4) Outside Spring Diameter: Not less than 80 percent of the compressed height of spring at rated load.

(5) Minimum Additional Travel: 50 percent of the required deflection at rated load.

(6) Lateral Stiffness: More than 0.8 times the rated vertical stiffness.

(7) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

(8) Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.

(9) Vertical Limit Stops: Where required or shown, provide resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed.

(10) Rubber Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.

(11) Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.

(12) Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.

(13) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

(14) Minimum Additional Travel: 50 percent of the required deflection at rated load.

(15) Elastomeric Element: Molded, oil-resistant rubber or neoprene.

(16) All-directional acoustical pipe anchor shall consist of two sizes of steel tubing separated by a minimum ½" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction.

(17) Seismic solid braces shall consist of steel angles or channels to resist seismic loads with minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connection shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number OSHPD in the state of California verifying the maximum certified load ratings.

(18) Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top. The upper portion shall have holes for rebar to pass through. The anchor should be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping anchors shall be attached to the structural slab using stud wedge anchors.

(19) Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that was "rolled up" to create the thread. The stud anchor shall also have a safety shoulder, which fully support the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying its allowable loads.

(20) Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying to its allowable loads.

B. VIBRATION ISOLATION BASES

(1) Fabricated Steel Bases: Structural-steel bases and rails designed and fabricated by the isolation equipment manufacturer. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.

(2) Fabricate bases to shapes required, with welded structural-steel shapes, plates and conforming to ASTM A 36 (ASTM A 36M). Include support brackets to anchor base to isolators units. Include pre-located equipment anchor bolts and auxiliary motor slide bases or rails.

(3) Design and fabricate bases to result in the lowest possible mounting height with not less than an inch (25-mm) clearance above the floor.

(4) Concrete-Filled Inertia Bases: Weld reinforcing bars to the structural frame. Pour concrete into base with relocated equipment anchor bolts.

(5) Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.

(6) Configure inertia bases to accommodate equipment supported.

(7) Pump Bases: Size to support pump and piping elbows.

(8) Factory Finish: Manufacturer's standard corrosive-resistant finish.

3. EXECUTION

A. INSTALLATION

(1) Install and anchor vibration-, sound-, and seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.

(2) Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.

(3) Filled concrete inertia bases, after installing base frame, with 3000-psig (20.7-Mpa) concrete, and trowel to a smooth, hard finish. Cast-in-place concrete is specified in Division 3.

(4) Isolate duct as follows:

a. Provide spring and neoprene hanger or floor spring mount on all duct discharge runs for a distance of 50' from the connected equipment. Spring deflection shall be a minimum of 0.75".

b. Provide pre-compressed spring and neoprene hanger or floor spring mount on all duct runs having air velocity of 1000 fpm or more. Spring deflection shall be a minimum of 0.75".

(5) Isolated piping as follows:

a. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be pre-compressed spring and neoprene type. Floor supported piping shall rest on spring type isolators. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1 ½" deflection for pipe sizes up to and including 6", and 2 ½" deflection thereafter.

b. Riser isolation: Risers shall be suspended from spring and neoprene hangers or supported by floor spring isolators, all-directional acoustic pipe anchor, and pipe guide. steel springs shall be a minimum of 0.75" except in those expansion locations where additional deflection is required to limit load changes to +25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

B. SEISMIC CONTROL

(1) All mechanical systems are to be seismically restrained. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical (equipment not listed is still included in this specification).

(2) Ductwork, where seismically restrained, must be reinforced. Reinforcement shall consist of all additional angel on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.

(3) Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases.

(4) Snubbers: Install the required number of seismic snubbers on each spring-mounted piece of equipment. Locate snubber as close as possible to the vibration isolators and bolt to supporting structure.

(5) Manufacturer shall provide installation instructions, drawings and trained field supervision to ensure proper installation and performance. Visit the project site before installation is begun and instruct installers in correct installation procedures for vibration isolation, seismic restraints and concrete pads. Observe installation of other work related to vibration isolation and seismic work, including concrete pad installations; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover the following:

a. Equipment installations (performed as work of other sections) on vibration isolators and Seismic restraints.

b. Piping connections including flexible connections.

c. Ductwork connections including provisions for flexible connections.

d. Passage of piping and ductwork which is to be isolated through walls and floors.

e. Installation of isolators and seismic restraints on duct and piping systems.

(6) Do not start-up equipment until inadequacies have been corrected in manner acceptable to Vibration Isolator and Seismic Controls Manufacturer.

(7) Spacing for restraints shall be as follows, except where lesser spacing is required to limit anchorage loads:

a. Ductwork and electrical services (conduit, bus ducts, cable trays, and ladder trays) transverse restraints shall occur at 30’ intervals (or at both ends of the duct run if less than specified interval) and longitudinal restraints shall occur at 60’ intervals (with at least one restraint per duct run). Transverse restraints shall be installed at each duct/electrical service turn and at each end of a duct/electrical run.

b. Walls including gypsum board non-bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

END OF SECTION 202600

SECTION 203100 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

1. GENERAL

   A. The General Conditions, Instructions to Bidders, Section 200100, and other Contract Documents are a part of this specification and shall be binding on all Mechanical Contractors. It shall be each Contractor's responsibility to apprize himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.

   B. The Engineer, or his authorized representative, shall be notified by the Contractor twenty-four (24) hours in advance of any tests called for in these specifications or required by others. Any leaks or imperfections found shall be corrected and a new test run to the satisfaction of the Engineer or his authorized representative. Upon completion of a test, a written approval of that part of the work will be given to the Contractor. Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow his work to be furred in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

2. PLUMBING

   A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

   B. Water piping systems shall be subjected to a hydrostatic test of one hundred fifty pounds. The system shall be proven tight after a twenty-four (24) hour test.

   C. The house drain line, interior storm sewers, interior rainwater conductors, and all soil, waste and vent piping shall be subjected to a hydrostatic test of not less than a 10-foot head or an air test of not less than 5 lbs. per sq. inch using a mercury column gauge and shall hold for 15 minutes.

   D. Exterior sewer lines to the termination point outside the building shall be subject to a ten-foot hydrostatic test or an approved smoke test. These lines shall be subjected to a second test after 2 feet of backfill has been properly installed.

   E. After piping has been installed, the entire plumbing system, exclusive of the house sewer, shall be subjected to an air pressure test equivalent to one-inch water column and proven tight. The Contractor responsible shall furnish and install all of the test tees required, including those for isolating any portion of the system for tests.

   F. Thermometers and gauges shall be checked for accuracy. If instruments prove defective, they shall be replaced.

   G. The Contractor shall perform all additional tests that may be required by the Kentucky Department of Health or other governing agency.

   H. Set temperature control on water heaters and adjust tempering valves as required.

   I. Balance the water flow rate of each domestic hot water recirculating pump. Set the flow rate for each balancing valve in the recirculating hot water system. If flow rates are not indicated, contact the engineer for each balance valve GPM.

J. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.

K. The compressed air system shall be tested for leaks for eight (8) hours at 250 PSI.

L. The natural gas piping shall be tested in accordance with requirements and/or recommendations of the local gas company.

M. Fuel oil piping shall be static tested at 250 PSI for eight (8) hours.

3. HEATING, VENTILATING AND AIR CONDITIONING

A. The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic test of not less than one hundred pounds and shall be proven tight after a twenty-four (24) hour test.

B. All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating, and control valves shall be adjusted. Excessive noise or vibration shall be eliminated. Provide all start-up documents to Designer prior to any test and balance services.

C. System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.

D. All fan belts shall be adjusted for proper operation of fans.

E. All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.

F. For the purpose of placing the heating, ventilating and air conditioning system in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council. The following systems shall be test and balance:

(1) The supply, return and outside air duct systems associated with all AHUs as included in this project phase. Provide static pressure profiles thru each system. Static pressure profiles shall include all sections from the return duct inlet and supply duct outlet of the air handling unit. Show accurate representation of return, relief, outdoor and economizer damper locations. On units equipped with return air fans; show location and profile of the return fan.

(2) All AHU supply and return duct air leakage testing, and exhaust duct air leakage testing as required per Section 231200, *for duct systems installed in this bid package.*

~~*(3) The chilled water pumps and chilled water coils.*~~

(4) The baseboard heating system pumps and baseboard heating coils.

(5) Pressure testing of all AHU's to confirm compliance with the requirements of spec section 237314 - FACTORY BUILT CUSTOM INDOOR AIR HANDLING UNITS.

~~*(6) The hot water pumps and hot water coils.*~~

(7) Balance all supply, return and exhaust air grille to within 10% of design air flow rate.

(8) ~~*Balance all exhaust air fans and record inlet static pressure.*~~

~~*(9) Balance domestic hot water return system including all balance valves and record settings and flows.*~~

(10) Pressure test ductwork as required by sheet metal specification section 231200.

H. Provide a preliminary test report to the mechanical engineer immediately after the system is air balanced, or any initial phases are balanced. This report may be hand written. Anticipate visiting the site again after the engineer has reviewed the report. The engineer may request up to 15 additional static pressure measurements for any air handling system to help resolve any balancing deficiencies. Include five additional static pressure measurements for each exhaust air system.

I. The Test and Balance agency shall provide lifts, scaffolding, etc. as required to balance devices in areas with high ceilings. The Test and Balance agency may coordinate with the General Contractor or Mechanical Contractor to arrange for these items to be provided to access high devices, however, it is emphasized the Contractor is finally responsible for providing the means required to balance all devices.

J. Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.

K. Test and Balance agency is to provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor will purchase and install all sheaves and belts as required. This includes new and existing equipment.

L. Four (4) copies of the complete test reports shall be submitted to the Consulting Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.

M. The Contractor shall provide and coordinate their work in the following manner:

(1) Provide sufficient time before final completion date so that tests and balancing can be accomplished.

(2) Provide immediate labor and tools to make corrections when required without undue delay.

N. The Contractor shall put all heating, ventilating and air conditioning systems and equipment and range hood system into full operation and shall continue the operation of same during each working day of testing and balancing.

O. The test and balance contractor shall be present during the Engineer's final inspection of the building, or a separate project review date. The Engineer may request confirmation of the air balance report by asking for new measurements to be taken at that time. Any information in the test and balance report may be asked to be reconfirmed.

END OF SECTION 203100

SECTION 203200 - MECHANICAL MAINTENANCE

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. MECHANICAL MAINTENANCE CONTRACT

   A. In addition to all other work indicated and specified, the Contractor shall provide the necessary skills and labor to assure the proper operation for all equipment and controls provided under Division 20 for a period of one year after substantial completion of the contract as defined in these specifications.

   B. The Contractor shall receive calls for any and all problems experienced in the operation of the equipment provided and shall take steps to immediately correct any deficiencies that may exist.

   C. The Contractor shall provide monthly inspection of all equipment and record the findings on a check list hereinafter specified.

   D. All equipment that requires repairing shall be immediately serviced and repaired. Since the period of maintenance runs for one year concurrently with the warranty and guarantee, all parts and labor shall be furnished at no extra cost to the Owner.

   E. Control System - Once each month, the Control Sub-Contractor shall check all controls in the building to ascertain that they are functioning as designed and installed. This shall apply to all thermostats, aquastats, humidistats, freezestats, and firestats. This portion of the work shall be performed only by the Sub-Contractor that installed the controls.

   F. When emergency service is required beyond regular working hours to maintain the system in operation, the Contractor shall furnish such service.

   G. Failure on the part of the Contractor to comply with all or part of this section of his work, will be required to relinquish a portion of his original contract sum. In general, that cost will be determined by the cost incurred by the owners to have work accomplished which should have, by contract, been accomplished by the Contractor.

END OF SECTION 203200

SECTION 210100 - FIRE PROTECTION SYSTEM

1. GENERAL

A. The General Conditions, Instructions to Bidders, Section 200100, 1. A, and other Contract Documents are a part of this specification and shall be binding on the Contractor. It shall be the Contractor's responsibility to apprise himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.

B. No Contractor, other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems, will be considered or approved for the work under this section of the specifications. Bidders must have had not less than five (5) years experience in the fabrication and erection of such systems: wet, dry and rack storage types, and shall have completed installations similar and equivalent in scope to this system under approval by one or more of the recognized Underwriting Associations in the Insurance Field.

C. Before submitting bid, examine all Mechanical, Architectural, and Structural Drawings, visit the site and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work. Also, the Contractor shall coordinate with the rating bureau and insuring agency to verify adequacy of water supply for the proposed sprinkler system extension.

D. The Contractor shall take his own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Where variations exist between described work and approved practice, the Engineer shall be consulted for directive.

E. It is the intent of the Plans and Specifications to provide a general layout only and locate major equipment, piping, etc. Variations in head locations, pipe routing, etc., may be anticipated by the Contractor and shall be coordinated with all other trades and indicated on the drawings and descriptive literature called for hereinafter. It shall be the express responsibility of the Contractor to provide all required materials and equipment and perform all work required to install a complete and approved installation.

F. All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and the State Fire Marshal. Also, all work shall comply with the latest editions of the National Board of Fire Underwriters, National Fire Protection Association, OSHA Regulations, the National Building Code, the Life Safety Code, IMC Code and the Southern Building Code (Where applicable). The local insuring agency shall review plans prepared and submitted by the Contractor but shall have no authority to make changes once work has begun.

G. All work performed under this section shall be accomplished in close harmony with all other trades. All work not so coordinated shall be removed and reinstalled at the expense of the Contractor.

H. The Contractor shall submit a proposed layout to the Engineer prior to submittal to the Fire Marshal's Office.

2. SCOPE OF WORK

A. Furnish all material, labor, tools, equipment and supervision required for installation of a complete fire protection and stand pipe system as indicated on the project drawings. Include all necessary piping, sprinkler heads, test connections, valves, drains, cabinets, siamese connections, fire hydrants, fire pump, etc.

B. The Contractor shall provide flushing and sterilization of all water lines in accordance with current Kentucky Plumbing Codes, Rules and Regulations and shall make connection to domestic water mains in accord with current rules and regulations of the State Department of Sanitary Engineering and Division of Water.

C. Provide stand pipes with fire hose cabinets or fire valves as indicated or as required to meet the requirements of NFPA and the local fire authority.

D. Provide sprinklers in attics, overhangs, awnings, cooler/freezers, in accessible spaces and all other areas required by NFPA and the local fire authority.

E. Provide dry pipe systems or freeze proof heads as required to provide continuous coverage without freezing.

F. Provide seismic restraints in accordance with the Seismic Restraint specification section 202600.

3. WATER SUPPLIES AND SYSTEM LAYOUT CRITERIA

A. Where flow and pressure data are available, they are indicated on the project drawings. The Contractor shall independently verify all such information and notify the engineer of any discrepancies discovered prior to beginning the work. Where no flow information is indicted on the project drawings, the Contractor shall obtain it and indicate it on the shop drawing submittal. Piping systems shall be hydraulically sized based on the most conservative flow information obtained. No adjustments in the contract amount will be allowed for failure of the Contractor to obtain adequate flow information.

4. DRAWINGS AND DESCRIPTIVE LITERATURE

A. The Contractor shall prepare and submit to the Engineers, an electronic copy of detailed drawings indicating his proposed Automatic Sprinkler System. These drawings shall indicate minimally the following components when they are used in the system.

(1) Name and address of Owner, Architect and Engineers.
(2) Make and type of sprinkler heads (Catalog cuts).
(3) Make and type of fire department connection (Catalog cuts).
(4) Make and type of post indicator valve (Catalog cuts).
(5) Make and type of detector check valve (Catalog cuts).
(6) Make and type of electric alarm bell (Catalog cuts).
(7) Make and type of flanged check valve (Catalog cuts).
(8) Make and type of flanged gate valve (Catalog cuts).
(9) Make and type of automatic drains (Catalog cuts).
(10) Make and type of pipe hangers (1 catalog cut of each make and/or type).
(11) Make, type and electrical characteristics of:

a. The pressure sensing switch*.
b. The post indicator supervisory switch*.
c. The main gate valve supervisory switch*.

d. The flow switch*.
e. Air compressor.

(12) Make and type of fire pump (Catalog cuts).
(13) Make and type of jockey pump (Catalog cuts).
(14) Make and type of supervised O.S & Y valve.
(15) Make and type of indicating butterfly valve.
(16) Make and type of fire hose cabinets.
(17) Make and type of reduced pressure backflow preventer.

Note: All layouts and drawings are to be closely coordinated with the work of all other trades. The Engineers will, upon request, provide a complete set of Architectural, Structural, Mechanical and Electrical Plans and Specifications to aid the Contractor in this work.

*SPECIAL NOTE: 1) The items (indicated by asterisk) must be clearly coordinated with the Fire Alarm System supplier. 2) Supervisory switches located in wet locations (i.e., fire protection vault) shall be provided with NEMA 6 enclosures.

(18) On a set of drawings to the same scale as the drawings accompanying these specifications, indicate:

a. Each head location coordinated with lights, diffusers and other ceiling mounted device.
b. Location of all risers, mains, runout lines, etc.
c. Size of all risers, mains, runout lines, etc.
d. Location and type of pipe hangers.
e. All other information required by the Kentucky Department of Housing, Buildings and Construction.

The Contractor shall submit these drawings to the Engineer through the General Contractor/Construction Manager and Architect where applicable. The Contractor shall submit reviewed drawings to the Kentucky Department of Housing, Buildings and Construction for their review and approval. No work shall be done until drawings are approved by the Kentucky Department of HBC.

5. SYSTEM DRAINAGE

A. The entire Standpipe and Sprinkler System (except that part which is below grade and will not freeze) shall be installed so as to allow 100% drainage.

B. All sprinkler branch piping shall be installed so as to drain back to the main riser.

C. Approved 2" drawoff piping shall be provided on sprinkler risers with discharge piping running to nearest floor drain or open air.

D. Where sprinkler piping is trapped, an approved auxiliary draw-off shall be provided and neatly installed.

E. All draw-offs shall have a metal tag labeled "Sprinkler Drain."

6. INSPECTIONS AND TESTS

A. Furnish all labor, equipment and conduct all required tests in the presence of the Owner and Engineer or designated representative.

B. All piping and devices comprising the fire protection system shall be tested under hydrostatic pressure of not less than 200 PSI and maintained for not less than two (2) hours.

C. Upon completion of his work, the Contractor shall submit a written and signed certificate to the Engineers indicating that he performed the above prescribed tests and rectified all malfunctions arising there from.

7. PERMITS

A. The Contractor shall obtain and pay for all necessary state, municipal, county, city and other permits and fees and pay all State taxes which are applicable.

8. GUARANTEE

A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, for a period of one year after date of final acceptance.

9. ACCEPTANCE CERTIFICATE

A. Upon completion, the Contractor shall submit to the Engineers, a properly filled out "Sprinkler Contractor's Certificate Covering Materials and Tests." (4 copies).

10. CLEANING

A. Upon completion of this work all debris, material, and equipment shall be removed from the building and premises; all piping shall be cleaned ready for finish painting. Note: Do not remove rust inhibitive primer specified hereinafter.

11. PAINTING

A. All fire protection piping, fittings, etc., shall have one factory or shop coat of rust inhibitive primer. The Contractor shall thoroughly clean all such items in areas where the piping will be exposed so as to readily receive the finish coat specified in the Architectural Division of Painting. Colors shall be as specified in Identification Section of these specifications.

12. PIPE LAYING

A. Bell holes shall be excavated accurately to size and barrel of pipe shall bear firmly on bottom of trench throughout its length. All foreign matter and dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying. At times when pipe laying is not in progress, the open ends of pipe shall be closed by approved means, and no trench water shall be permitted to enter the pipe. Cutting of pipe, where necessary, shall be done in a neat and workmanlike manner, without damage to pipe. Refer also to Excavation.

13. EQUIPMENT AND MATERIALS

A. Signs

Appropriate code approved and required signs shall be installed on all control valves, drains, inspector's test, etc., indicating the function, installation, etc. Signs shall be neatly affixed with rust inhibitive screws, rivets or where hung from piping; with stainless steel No. 14 AWG wire.

B. Finish

All exposed materials such as valves, fire department connections, sprinkler heads, fire pump test headers, etc., shall be brass or chrome-plated brass.

C. Check Valves

(1) 2-1/2" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; flanged; equivalent to Mueller, Scott or Lunkenheimer.

(2) 2" and under; 150# working pressure; bronze; screwed; equivalent to Jenkins, Scott or Lunkenheimer.

D. Pipe & Fittings

(1) Nipples and fittings shall be of same material, composition, and weight classification as pipe in which installed.

(2) Up to 2" (Interior) Schedule 40 ASTM A-53 black steel; 125# cast iron screwed fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.

(3) 2-1/2" and larger (Interior) Schedule 40 black steel with flanged, welded or victaulic (or similar) type approved fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.

(4) Exterior: Schedule 150 ductile iron with cement mortar lining and gasketed joints. Piping shall, be UL listed, Factory Mutual approved and NSF approved. No. 8 copper wire (tracer wire) shall parallel all exterior pipe.

(5) Dry Pipe System Piping: Same as standard system except Schedule 10 piping is not acceptable.

E. Clamps and Anchors

(1) Furnish and install approved clamps, as required, at all (45 degree) l/8 bends, (90 degree) 1/4 bends and flange and spigot pieces to the straight pipe to ensure permanent anchorage of all fire lines. Clamps, clamp rods, nuts, washers, and glands shall be coated with a quick drying coal tar bituminous paint after installation.

F. Hangers

(1) All piping shall be adequately and permanently supported in an approved manner on approved hangers (Submit with drawings).

G. Sleeves and Escutcheon Plates

(1) Furnish and install sleeves for pipes where piping penetrates masonry walls; exterior wall sleeves to be watertight. Fire and smoke stop all penetrations through fire and smoke walls and coordinate with General Contractor for locations.

(2) Furnish and install cast brass chrome plated split ring type escutcheons where piping penetrates walls, ceilings and floors, whether in finished areas or not.

H. Electric Wiring

(1) All electric wiring for the system which may be required shall be installed in accordance with the National Board of Fire Underwriters, and National Electric Code. The cost of this electric wiring shall be included under this Contract. All electrical wiring and conduit installed in fire protection pits shall be sealed watertight.

I. Inspection Test Connections & Pressure Gauges

(1) A 1" inspection test connection as required by the Kentucky Building Code. Discharge shall run to open air.

(2) Control valve for test connection shall be installed not over 7' above the floor.

(3) A pressure gauge at the inspection. Test connection at each location indicated on the Plans. Pressure gauges shall be 2-1/2" diameter and readable from the floor.

J. Gate Valves

(1) 2-1/2" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; OS&Y; flanged; cast iron discs; bronze seat rings; four-point wedging mechanism; equivalent to Mueller, Scott or Lunkenheimer.

(2) 2" and under; 150# working pressure; bronze; rising stem; screwed; bronze discs; bronze seat rings; two-point wedging mechanism; equivalent to Jenkins, Scott or Lunkenheimer.

K. Sprinkler Head Cabinet

(1) Furnish and install a cabinet, clearly labeled, with four (4) sprinklers of each type complete with required wrenches. Locate as directed by Engineer. Label "Sprinkler Heads."

L. Fire Department Connection

(1) Furnish and install a fire department connection with threads as approved by the local fire department; cast brass polished and chromium plated; with connection sizes and lettering as directed by the local authority having jurisdiction; Units shall be Acron Brass or equal single 4" nozzle, clapper, etc.

M. Fire Hose Valve

(1) Manufacturer. The products specified hereunder shall be Crocker or equivalent by Elkhart, Central Sprinkler, Kidde, or other nationally recognized manufacturer of hose valves conforming closely to specification requirements. Valve shall be with cap and chain. All connections shall be 2½" or as required by the local authority.

N. Detector Check Valve

(1) Furnish and install detector check valve as required by the local authority. It shall be listed and approved by Underwriter Laboratories and Associated Factory Mutual Laboratories; 175# working pressure; IBBM; flanged; with tapped bosses each side for by-pass meter trimming; equivalent to Viking, Badger or Grinnell.

(2) The Contractor shall contact the servicing water company and ascertain their policy pertaining to the by-pass water meter; if not furnished by water company. The Contractor shall furnish and install the by-pass meter and trimming as detailed on the drawings.

O. Sprinkler Heads

Gem, Grinnell, Star, Viking, Reliable, Central or approved equivalent as follows:

(1) Where piping is exposed: "Standard up right."

(2) Where piping is concealed above finished ceilings, provide two pieces, semi recessed, white plated sprinkler heads with removable escutcheon.

(3) Install sprinkler head guards where heads are subject to physical abuse. Heads located below seven (7) feet above floor, etc.

(4) Sprinkler head degree ratings shall be determined by the area serviced in accord with current Codes and Standard Practices. Indicate degree ratings on submitted Shop Drawings.

(5) The Contractor shall submit to the Engineer for inspection, one (1) sample of each type of sprinkler head, proposed to be used on the project.

(6) Where heads are installed in a tile ceiling, they shall be installed in the middle of the tiles, at half or quarter points along the length of the tiles. Install sprinkler heads at quarter points of center scoured 2' X 4' ceiling tiles.

(7) Provide high temperature heads around range hoods, kitchen equipment, kilns, boilers, water heaters and other heat producing equipment.

(8) **Light hazard occupancies only –** Install quick response heads.

P. Electric Alarm Bell

(1) Furnish and install an electric alarm bell.

Q. Flow Indicator Switches

(1) Furnish and install flow indicator switches as required by NFPA 13. All flow indicator switches shall be UL approved. Coordinate with Fire Alarm System supplier/installer. Provide a set of dry contacts on each flow switch for interface to the Control System if this control point is specified in the Controls Section.

R. Tamper Switches for Water Shut-Off Valves

(1) Furnish and install tamper switches where required by NFPA 13. All tamper switches shall be UL approved. Coordinate with fire alarm system supplier/installer. All tamper switches

located in fire protection pits shall be waterproof, capable of operating beneath water similar to Potter PTS Series and be NFPA approved.

S. Preaction System

(1) Provide a Single Interlocked Preaction cabinet with electric release containing all hydraulic and electrical components required for the control of a preaction system. The cabinet shall include the following:

a. Self-contained unit (with control panel) in sturdy free-standing 14-gauge steel cabinet, measuring:

1) 71"x36"x20" (180x91x51cm) for 1 ½", 2" & 3" systems

2) 71"x46"x24" (180x117x61cm) for 4" & 6" systems

b. Textured rust proof coating, inside and outside, fire red, oven baked polyester powder on phosphate base.

c. Two locked access doors to reduce front area required for opening, easily removable without tools to allow easy installation & servicing.

d. Individual access doors for the hydraulic and electrical sections and the emergency release (unlocked) with a neoprene gasket to avoid vibrations.

e. Deluge Valve, complete with Schedule 40 galvanized steel trim rated at 250 psi.

f. Integrated control panel, with emergency batteries in a top enclosure including a sprinklers storage rack.

g. Field wiring terminal strips integrated with the cabinet for connection of field wiring for detection system, audible devices, auxiliary contacts and power supply for air compressor.

h. Pressure gauges to indicate water supply pressure, priming water pressure and air pressure of the system.

i. Release trim with solenoid valve and each supervisory device required.

j. Schedule 40 steel pipe header with grooved ends to be connected to supply water.

k. Schedule 40 steel pipe drain manifold of 2" diameter for drain connections. Open drain cups in the cabinet and multiple drain manifolds will not be accepted.

(2) The cabinet assembly must be pre-assembled, pre-wired and factory tested under ISO-9001 conditions. It shall also be c-UL-us Listed, FM and MEA Approved as an assembled unit.

(3) Complete and functioning system shall meet all applicable codes, as listed below:

a. NFPA 13 (Installation of Sprinkler Systems)

b. NFPA 25 (Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems)

c. NFPA 72 (Standard for the Installation, Maintenance, and Use of Protective Signaling Systems)

d. NFPA 72E (Standard on Automatic Fire Detectors)

e. KBC (Kentucky Building Code)

f. National Building Code

g. National Fire Code

h. National Electrical Code

(4) Provide a complete electrical detection system including: system tubing, wiring, smoke detectors, signaling devices and connections to auxiliary functions. Provide detection and alarm indicating devices (24 Vdc bell, horn or strobe) to be compatible with the release control panel. A bell or a horn should be provided near the cabinet.

(5) Provide an internal air compressor as required for supervisory air. The air supply must be regulated and of the proper size in order to be able to restore normal system air pressure within 30 minutes. Size compressor as required for specific project. 120VAC, 60Hz. Air compressor and supervisory trim shall be factory installed inside the cabinet and adjusted for the required configuration.

(6) Sprinkler heads for the preaction system shall be as allowed by NFPA 13 for preaction systems and as specified in these specifications.

(7) The installation of the Preaction system must meet all established standards and be according to all applicable laws, regulations and codes. The proper operation and coordination for the system's installation, including the automatic sprinkler system, detection system, signaling system and initial start-ups are all under the responsibility of the contractor.

(8) The contractor must plan and organize a training session of at least two hours for the building maintenance staff, in the presence of building owner or his representative. The training session must include the normal operation, emergency procedures and system maintenance.

(9) Testing and Verifications of the system shall be as follows:

a. Hydrostatic tests must be performed on the entire sprinkler piping system, as required by NFPA 13.

b. In addition to the standard hydrostatic test, an air pressure leakage test at 40 psi (2.8 bars) shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1 1/2 psi (0.1 bar) during the 24 hours shall be corrected.

c. A drain test using the auxiliary drain valve fully open (drain located on water supply side, deluge valve inlet) must be performed to make sure that no back pressure in drain piping exists, which could affect the proper operation of the preaction system.

d. An air supply test must be performed, to confirm that normal air pressure can be restored within 30 minutes.

e. The verification of the fire alarm system must be done in accordance with the NFPA 72.

(10) An inspection report and a certificate must be supplied to the engineer at the completion of the project. All tests results shall be registered in a booklet to be included with the inspection report.

(11) Acceptable Manufacturers: Reliable, Viking or Fire Flex.

14. GUARANTEE

A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, or vandalism, for a period of one year after date of final acceptance.

END OF SECTION 210100

SECTION 210200- FIRE PUMPS

1.00 PART 1 - GENERAL

1.01 Description of Work

A. Provide pumps for fire suppression.

1.02 Section Includes

A. Single Stage, Double Suction, 6x5x17 SSC Horizontal Splitcase Fire Pump

RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to this Section.
- Section 200300 - Submittals
- Section 220060 – Plumbing Pipe and Fittings
- Section 200100 - Mechanical General Requirements
- Section 250100 - Electric Motors
- Section 260501 - Electrical General Requirements
- Section 210200 - Fire Pump Controllers
- Section 210200 - Jockey Pumps
- Section 210200 - Controller – Jockey Pump

1.03 Quality Assurance

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

B. The fire pump shall be assembled by the pump manufacturer. An assembler of fire pumps not engaged in the design and construction of fire pumps shall not be considered as a fire pump manufacturer. The manufacturer shall assume “Unit Responsibility” for the complete fire pump. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.

C. Ensure pump pressure ratings are at least equal to system’s maximum operating pressure at point where installed, but not less than specified.

D. The manufacturer shall have a minimum of 20 years’ experience in the design and construction of fire pump systems.

E. The manufacturer shall carry a minimum product liability insurance of $2,000,000 per occurrence, with an aggregate product liability of $5,000,000.

F. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. This pump start-up shall be by the pump manufacturer or a certified factory-trained representative per NFPA 20, Section 11-2. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner’s designated representative. This job site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and

signed off on the manufacturer's start-up request form.

1.04 Product Handling

A. Protection: Use all means necessary to protect equipment before, during, and after installation in accordance with manufacturer's storage, installation and maintenance instructions.

1.05 Regulatory Requirements

A. National Fire Protection Association (NFPA 20)
B. Factory Mutual (FM)
C. Institute of Electrical and Electronic Engineers (IEEE)
D. National Electrical Manufacturers Association (NEMA)
E. American Society for Testing and Materials (ASTM)
F. National Electric Code (NEC)
G. Occupational Safety and Health Administration (OSHA)
H. ANSI/HI standards
I. Underwriters Laboratories, Inc.

1.06 Submittal

A. Submit each item in this article according to the Conditions of the Contract and Specifications Sections

B. Submit manufacture's installation instructions under provisions of General Conditions.

C. Product Data including certified performance curves and rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curve.

D. Hanging and support requirements should follow the recommendations in the manufactures installation instructions.

E. The fire pump shall be submitted with the Fire Protection Drawings to the State for review and approval.

1.07 Operation and Maintenance Data

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

1.08 Delivery, Storage, and Handling

A. Deliver materials to the site in such a manner as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids. Materials damaged by the elements should be packaged in such a manner that they could withstand short-term exposure to the elements during transportation. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.

1.09 Warranty:

A. Provide a minimum one (1) year warranty from the date of Substantial Completion.

1.10 Commissioning

A. This section specifies a system or a component of a system being commissioned as defined in Commissioning Specifications.

2.00 PART 2 - PRODUCTS

A. The specifying engineer reserves the right to specify a primary supplier/lead spec manufacturer on all supplied schedule and specification documents. These primary suppliers have lead their respective industry in research and development and their products have had proven track records in the field. These primary suppliers, in the opinion of this engineering firm, produce a superior product to the other manufactures.

2.01 Single Stage, Double Suction, Horizontal Splitcase 6x5x17 SSC Fire Pumps

A. Manufacturer

Contractor shall furnish and install an Patterson supplied by Vulcan Fire Systems that is UL listed and FM approved double suction horizontal split-case pump, Model 6x5x17 SSC, for fire suppression. The pump(s) shall conform to the standards of NFPA 20 latest edition for the Installation of Centrifugal Fire Pumps. Acceptable manufacturers include AC Fire Pump, Peerless, Synchro, Paterson.

B. Double Suction Horizontal Split-case Pump

1. The pump will provide a rated capacity of 1,000 GPM and a differential pressure of 85 PSI. At 150% of rated capacity, the pump shall develop at least 65% of its rated head and shall not exceed 140% of the rated head at zero capacity. The pump shall be tested at the factory and a test curve shall be submitted showing the performance and horsepower requirements based on this test before final acceptance.

2. The pump shall be a single stage, double suction, horizontally split case design, in cast iron bronze fitted construction with packing bearing directly on a bronze shaft sleeve. The casing shall be (close-grained cast iron ASTM A48 Class 35A for working pressures up to 175 psig), (ductile iron for working pressures up to 400 psig), and shall be of axially-split design with suction and discharge flanges and mounting feet cast integral with the lower half casing. Tapped and plugged holes shall be provided for priming, vent drain and gauge connections. The pump internals shall be capable of being serviced by removing the upper half casing without disturbing the piping connections or packing area. Flanges shall be 125# or 250# per ANSI B16.1 Standard. Suction and discharge shall be on a common centerline in both horizontal and vertical planes.

3. The impeller shall be of the enclosed double suction type made of bronze ASTM B584-875 non-overloading in operating characteristics utilizing the motor service factor, statically or dynamically balanced. The impeller shall be keyed to the shaft and positioned axially by the shaft sleeves, which are, in turn, locked in place by shaft nuts.

4. The shaft shall be made of SAE-1045 Steel or better, and of ample size to operate under load with a minimum of deflection. Shaft shall not be threaded anywhere inside the pump casing.

5. The shaft sleeve shall be made of bronze ASTM B584-932 and shall be locked in place by threaded, bronze shaft sleeve nuts. An “O”-ring shall be furnished under the sleeve to prevent leakage.

6. Stuffing box housing/Bearing brackets shall be made of cast iron ASTM A48 Class 25A or Class 30A separate from the casing. Stuffing boxes shall not be split, but machined of one concentric piece to ease sealing. Stuffing box/bearing brackets will be drilled and tapped for drain connection. The stuffing box shall consist of graphited acrylic yarn packing, and a split type gland to permit removal and access to packing. Ample space shall be provided for re-packing the stuffing box.

7. Piping, valve and seal cages (if necessary) can be supplied to provide packing lubrication and shall be mounted on the upper half of the casing. Flush from an external source shall also be possible for lubrication and/or cooling.

8. Casing rings shall be made of bronze ASTM B584-932 and shall be installed with an anti-rotation device and designed to restrict leakage across the ring fit.

9. Bearings shall be grease lubricated ball type, single row inboard, double row outboard, selected to carry radial and thrust loads. The outboard bearing shall be retained by a bearing locknut and lockwasher. (Snap rings are not acceptable). The bearings, (inboard and outboard) shall be replaceable without opening the pump casing.

10. Bearing housings are made of cast iron ASTM A48 Class 25A or Class 30A, bolted to the ends of the bearing bracket/stuffing box and shall be male-female fitted for a full 360 degrees to assure positive alignment. The housings shall provide a fit for the inboard bearing that allows freedom for thermal expansion while the outboard bearing shall be clamped in place to take all thrust loads and keep the rotating element in its proper axial location. Openings for adding new grease and draining old grease shall be provided.

11. Baseplate shall be steel with or without drip pan, sufficiently rigid to support the pump and the driver. Final alignment of pump and driver shall be made after grouting and installation, and shall be approved by customer prior to operation.

12. Coupling shall be of the manufacturer's choice and of the flexible type. Coupling hubs shall be secured to the driver and driven shafts by a set screw located over the key.

13. Coupling guard shall be the can type, all metal guard rated per ANSI B15-1, Section 8 and OSHA 1910-219 compliant.

14. The driver shall be mounted with the pump on a baseplate at the pump manufacturer's plant and shipped as one unit.

15. Pump rotation shall be clockwise or counterclockwise when viewed from the driver.

16. Nameplates and other data plates shall be all corrosion resistant and suitably secured to the pump.

17. Pump manufacturer shall be ISO9001 certified.

2.02 Accessories

A. The 6x5x17 SSC Horizontal Splitcase Fire Pump shall be furnished with the following fittings as standard:

1. ¾" pilot operated casing relief valve (250 GPM through 2500 GPM)
2. ¾" automatic air release valve
3. 4" dial, liquid filled suction and discharge gauges

B. Other fittings and accessories will include the following:

1. Eccentric suction reducer (if required)
2. Concentric discharge increaser (if required)
3. 6” flush mount test header assembly with four (4) 2 ½” Hose Valves, finish to be polished chrome
4. 6” low suction control valve

2.03 Fire Pump Controller

A. Manufacturer
The electric fire pump controller and automatic power transfer switch will be manufactured by Firetrol and supplied by Vulcan Fire Systems, Inc. The electric fire pump controller will have a ViZi Touch operator interface. The fire pump controller shall be rated for 460v, 3 Phase, 60 Hz operation.

B. Listing and Approval
The electric fire pump controller and automatic power transfer switch shall meet the latest NFPA 20 requirements, be listed with UL (in accordance with UL218, UL1008 and CSA C22.2 No. 14 Industrial Control Equipment). approved by FM Global (in accordance with approvals Class 1321/1323).

C. Starting Method
The electric fire pump controller and automatic power transfer switch shall be a full-service combined manual and automatic type suitable for reduced voltage solid state starting of the electric fire pump motor.

D. Short Circuit Withstand Rating
The short circuit withstand rating of the electric fire pump controller and automatic power transfer switch shall be 100 kA RMS at 200V - 480V or 50 kA RMS at 600V.

E. Enclosure
The standard enclosure shall be NEMA type 2 (IP31). The enclosure shall incorporate a bottom entry gland plate for normal and alternate power and/or motor lead entrance. The gland plate shall be field removable and meet the same NEMA rating of the enclosure. Lifting lugs shall be provided.

F. Power Circuit Components
The electric fire pump controller and automatic power transfer switch shall be supplied with an across the line electric motor starter and the following power components for both the normal and alternate (emergency) power supply:
1. Voltage surge arrestor for normal
2. Motor rated combination isolating switch and circuit breaker assembly. Both the isolating switch and circuit breaker shall be rated not less than 115% of the motor full load current.
3. The circuit breaker overcurrent sensing shall be non-thermal type, magnetic only.
4. Locked rotor protector set to automatically trip the circuit breaker within 8 to 20 seconds at 600% of full load current. The locked rotor protector shall be factory calibrated, set and tested.
5. An automatic power transfer switch mechanically held and electrically operated. Manual operation of the transfer switch shall be provided by means of manual operating handle.

G. Operational Components
The electric fire pump controller and automatic power transfer switch shall be supplied with the following externally flange mounted components approved to match the NEMA rating of the enclosure:

1. Common operating handle for the isolating switch and the circuit breaker assembly for normal power
2. Common operating handle for the isolating switch and circuit breaker assembly for alternate (emergency) power
3. Mechanically interlocked with the enclosure door to prohibit access to the interior in the “ON” position
4. One “Emergency Start” and run handle mechanism, latchable in the “ON” position

H. Touch Screen Operator Interface

The electric fire pump controller and automatic power transfer switch shall be supplied with a 4.2” LCD color touch screen (HMI technology) operator interface powered by an embedded microcomputer with software PLC logic. The operator interface’s touch screen shall allow navigation through the various operating screens. The following keypad type pushbuttons shall be provided:

1. Start
2. Stop
3. Run Test
4. Navigation
5. Help
6. Home
7. Alarm(s)
8. Settings/Configuration
9. History/Statistics

The touch screen operator interface shall graphically display:

1. Normal and alternate (emergency) power voltage and amperage readings of all three (3) phases, simultaneously and independently displayed with true RMS technology
2. Transfer switch status
3. Motor starting transition
4. Motor stopped/running
5. Type of starting cause
6. Actuation mode
7. Type of controller
8. Method of shutdown
9. Time and date
10. Pump room temperature (*F or *C)
11. System pressure in five (5) different user selectable units of measure
    a. PSI
    b. kPA
    c. Bar
    d. Feet of Head
    e. Meter of Water

The touch screen operator interface shall allow for the program and display of:

1. Cut-in and Cut-out pressure settings
2. Minimum run period timer
3. Sequential start timer
4. Periodic test timer

The user shall be able to select the language of operation on-site

Contextual HELP screens shall be accessible to the user while navigating through the operator interface

I. Condition and Alarm Visual Indicators

The touch screen operator interface shall visually indicate alarms and differentiate the criticalness by color code:

1. Normal and alternate (emergency) power phase reversal
2. Normal and alternate (emergency) power phase loss
3. Locked rotor
4. Fail to start
5. Transfer switch trouble
6. Normal and alternate (emergency) power loss
7. Service required
8. Undercurrent
9. Overcurrent
10. Under voltage
11. Over voltage
12. Phase unbalance
13. Periodic test cut-in not reached
14. Periodic test solenoid valve check
15. Faulty pressure transducer
16. Low water level
17. Low system (discharge) pressure
18. Pump on demand
19. Over pressure
20. Under pressure
21. Alternate (emergency) power isolating switch “OFF”
22. Alternate (emergency) power circuit breaker open
23. Low pump room temperature

J. Pressure and Event Recording

The fire pump controller’s touch screen operator interface shall be capable of logging pressure data and operational events with time and date stamp. It shall be able to display the last 500 operational events and display the pressure data in text and/or graphic form. Under regular maintained operation, pressure data and operational events can be stored in memory for up to 5 years. The data shall also be retrievable and downloadable to a flash memory disk via the USB port accessible to the user without having to open the controller door. General system information, events and alarms include the following:

1. Last service statistics
    a. Powered since
    b. On time
    c. Motor last run
    d. Motor run time
    e. Motor start count
    f. Minimum, maximum, average system PSI
    g. Minimum, maximum, average pump room temperature
    h. Generator last run
    i. Generator run time
    j. Transfer switch transfer count
2. All time statistics
    a. First power up
    b. First start up
    c. On time
3. Power statistics
    a. Voltage between phases with date stamp
    b. Amperage between phases with date stamp

K. Wetted Parts (Pressure Transducers)
The electric fire pump controller and automatic power transfer switch shall be supplied with two (2) pressure transducers and run test solenoid valve assembly. The pressure sensing line connection to the pressure transducer shall be ½" FNPT. The second pressure transducer is provided as a backup to the primary setup. This assembly shall be rated 500psi (calibrated at 0-300psi) working pressure and be externally mounted with a protective cover. The electric fire pump controller's operator touch screen programming shall be designed to switch pressure transducers in the event of a primary failure.

L. Service/Flow Testing Capabilities
The electric fire pump controller's touch screen operator interface shall have the capability of scheduling maintenance reminders. It shall also have the capability of inputting pump flow test data, generate and display the pump curve and store this information in memory for the lifetime of the controller.

M. Connection for External Devices
The electric fire pump controller and automatic power transfer switch shall provide terminals for the connection for the following external devices:
1. Manual remote start device
2. Automatic remote start device
3. Deluge valve start
4. Generator start signal
5. System shall integrate into the Building Management System (BACnet)

N. Alarm Contacts for Remote Indication
SPDT dry alarm contacts rated for 8A – 250VAC for remote indication shall be provided for the following conditions:
1. Power or phase failure and/or circuit breaker in open position
2. Phase reversal
3. Pump run (2x)
4. Common pump room alarm (field re-assignable)
5. Common motor trouble (field re-assignable)
6. Emergency power isolating switch in the "OFF" position
7. Transfer switch in normal position
8. Transfer switch in emergency position
9. Field programmable

Removable alarm contact terminals shall be provided.

O. Audible Alarm
A 4" alarm bell rated for 85dB at 10ft (3m) shall sound during boot up and internal communication error.

2.04 Jockey Pump

A. The contractor shall install a vertical inline, multiple stage jockey pump manufactured by Grundfos and supplied by Vulcan Fire Systems. The jockey pump will be installed in accordance with NFPA 20.

B. The jockey pump shall be rated at 10% of the flow (GPM) and 15 PSI greater than the differential pressure of the main fire pump. The jockey pump shall be rated for 460v, 3 Phase, 60 Hz operation.

2.05 Jockey Pump Controller

A. Manufacturer

The jockey pump controller shall be manufactured by Firetrol and supplied by Vulcan Fire Systems. The jockey pump controller shall be rated for 460v, 3 Phase, 60 Hz.

B. Approval and Listings

The jockey pump controller shall meet the requirements of UL508A and CSA.

C. Enclosure Rating

The standard enclosure shall be NEMA 2

D. Operational Components

The jockey pump controller shall be supplied with the following door mounted components approved to match the NEMA rating of the enclosure:

1. One main disconnect switch complete with door interlock and padlock provision in the “OFF” position
2. One Hand-Off-Auto rotary type selector switch

The following control components shall be mounted inside the controller:

1. One magnetic across-the-line motor contactor rated for the jockey pump motor horsepower
2. One thermo magnetic motor protector complete with short circuit and motor overload protection

E. Microprocessor Logic

The jockey pump controller shall be supplied with a microprocessor to perform the automatic sequence of operation. The microprocessor shall be mounted inside the jockey pump controller and have a high luminosity LED digital display which shall display the following:

1. System Pressure
2. Cut-in pressure setting
3. Cut-out pressure setting
4. Minimum run period timer
5. Delay start timer

The system pressure indication shall be continuously displayed. The microprocessor shall allow the system pressure, cut-out and cut-in settings to be displayed in either PSI, Bar, kPa, meter of head, or feet of head.

F. Pressure Sensing Device
The jockey pump controller shall be supplied with a 316 stainless steel pressure transducer rated for fresh water operational between 0 and 300psi. The pressure transducer shall be used to display the pressure in the sprinkler system and also control the automatic start circuit. The pressure transducer shall be installed inside the controller directly mounted to a bulkhead allowing for an external connection to the sprinkler system sensing line

3.00 PART 3 - EXECUTION

3.01 Coordination

A. Coordinate installations with other contractors, specifically Division 26 and 28, to insure that a complete, operable system meeting the intent of these specifications and the plans that are provided.

B. Coordinate voltage on fire pumps, fire pump controllers, jockey pumps, and jockey pump controllers with electrical drawings.

3.02 Installation

A. Installations to be done by a licensed sprinkler contractor in the Commonwealth of Kentucky

B. Provide and install fire pump systems in accordance with NFPA 20 2010 edition, NFPA 25, these specifications, and as shown on the contract drawings

C. Prior to start-up, test all piping connections to insure that they are adequate

D. Prepare and test pumps to assure that it meets capacity as specified in these specifications. A factory representative shall be made available, on the project site, to check installation, provide flow acceptance testing, start-up, and demonstrate to the owner's representative(s) the proper operation and maintenance of each fire pump system.

3.03 Startup

A. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Commissioning section.

3.04 Functional Performance Tests

A. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Commissioning.

3.05 Owner Training

A. Provide training to the owner by a factory representative. Training shall be a minimum of eight (8) hours on site and the engineer shall be notified one (1) week in advance of the training. Training shall only occur when the systems are complete and 100% functional. All training shall be video taped.

END OF SECTION 210200

SECTION 220100 - PLUMBING SPECIALTIES

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work specified in this section.

   B. The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the State Building Code.

   C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

   D. Prior to final inspection, test by operation at least twice, all equipment.

   E. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from equipment and specialties and thoroughly clean same.

   F. All equipment and specialties shall be installed as recommended by the manufacturer in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.

   G. All pipes, valves, fittings, fixtures, etc. for use in potable water systems 2” and below shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. DRAINAGE SPECIALTIES

   A. GENERAL

      (1) Provide all drainage specialties indicated, specified and/or required to provide complete and acceptable removal of all storm, sanitary, waste, laboratory waste, etc. from the building and into approved receptors.

      (2) Drainage specialties shall be on non-electrolytic conduction to the material to which they are connected.

      (3) Drainage specialties shall be installed in a manner so as to ensure no leakage of toxic or odorous gases or liquids and shall have traps and/or backflow preventers where required. Nor shall they allow backflow into other or existing systems.

   B. CLEANOUTS - INTERIOR (CO)

      (1) In addition to cleanouts indicated, provide cleanouts in soil and waste piping and storm drainage at the following minimum locations:

         a. At base of each stack.
         b. At fifty (50) foot maximum intervals in horizontal lines.
         c. At each change of direction of a horizontal line.

d. As required by current KBC.
e. As required to permit rodding of entire system. (If in doubt, contact Engineers.)

(2) Water closets, slop sinks and other fixtures with fixed traps shall not be accepted as cleanouts.

(3) Cleanouts and/or test tees concealed in inaccessible pipe spaces, walls and other locations shall have an eight (8) inch by eight (8) inch (minimum) access panel or cover plates shall be set flush with finished floors and walls and shall be key or screw driver operable.

(4) Access panels for cleanouts shall be of the Zurn, 1460 series or equivalent by Josam or Watts. They may, at the Contractor's option, be Perma-Coated steel, prepared to receive finish. The Contractor shall coordinate the finish of all access panels installed in finished areas with Architect.

(5) Cleanouts and access panels shall be sized so as to permit the entry of a full sized rodding head capable of one hundred percent circumferential coverage of the line served.

(6) Provide a non-hardening mixture of graphite and grease on threads of all screwed cleanouts during installation.

(7) Do not install cleanouts against walls, partitions, etc. where rodding will be difficult or impossible. Extend past the obstruction.

(8) In finished walls, floors, etc., ensure that cleanouts are installed flush with finished surfaces and, where required, grout or otherwise finish in a neat and workmanlike manner.

(9) Cleanouts shall be as manufactured by Zurn, Josam, Jay R. Smith, Watts, MIFAB, Ancon or equivalent, similar to the following:

a. Zurn, Z-1440 cleanouts or Z-1445 cleanout tee at base of exposed stack and at change in direction of exposed lines.

b. Zurn, Z-1440 cleanout or Z-1445-1 cleanout tee where stacks are concealed in finished walls

c. Zurn, ZN-1400-T cleanout with square scoriated top in finished concrete and masonry tile floors.

d. Zurn, ZN-1400-Tx cleanout with square recessed top for tile in vinyl and linoleum finished floors.

e. Zurn, ZN-1400-Z cleanout with round recessed top for terrazzo floors.

f. Zurn, Z-1400-HD cleanout with tractor cover for exterior locations. Provide concrete supporting pad crowned to shed water. Refer to drawings for pad size.

g. Mueller, No. D-731 or D-714, Nibco, Flage or equivalent for cleanouts in copper waste with cover plates and/or access panels listed for other cleanouts.

h. Threaded hex head type cleanouts of same materials as pipe for piping 2" and smaller.

i. Zurn, cleanout with round top with adjustable retainer for carpet area. Install flush with carpet.

C. FLOOR DRAINS

(1) Provide floor drains at locations indicated and/or as required by State Building Code. Install in a neat and workmanlike manner. Coordinate locations with appropriate persons or party to ensure floor pitch to drain where required.

(2) Install floor drains in strict accordance with manufacturer's recommendations and the State Plumbing Code unless otherwise indicated.

(3) Each floor drain located on floors above the lowest floor shall be provided complete with a three (3) foot by three (3) foot, four (4) pound sheet lead flashing and clamping collar or chlorinated polyethylene shower pan liner of 30 mil. Lead pans shall be given a heavy coat of asphaltum on bottom and sides before installation and a heavy coat on exposed surfaces (if any). After installation, provide one ply of fifteen (15) pound roofing felt beneath each pan.

(4) Ensure by coordination with the appropriate persons or party that spaces served by a floor drain(s) has a water seal extending at least three (3) inches from the floor of the space served on all floors above the lowest level.

(5) The floor drains shall be Zurn, Josam, Watts, Jay R. Smith, MIFAB, Sioux Chief or equivalent.

D. TRAP PRIMERS

(1) Provide trap primers for all floor drains and open receptacle. Acceptable Trap Primer Manufacturers included Zurn, Precision Plumbing Products and Sioux Chief.

(2) For trap primers, any unused openings shall be capped.

(3) Provide an isolation valve for all trap primers.

E. CLEANOUTS (EXTERIOR) (ECO)

Provide exterior cleanouts at each location indicated and, in the manner, indicated. Permanently set all exterior cleanouts centered in a 30" X 30" X 6" deep concrete pad. The top of the concrete pad shall be flush with finished grade. The top of the cleanout box shall be flush with the top of the pad and shall be stamped "CO."

F. ROOF DRAINS

(1) Coordinate location of primary and secondary roof drains with Architectural roof plans.

(2) Each drain shall be provided complete with a three (3) foot by three (3) foot, four (4) pound sheet lead flashing and clamping collar. Roof drains shall be installed in strict accordance with the drain manufacturers and roofing manufacturer’s instructions. Provide all accessories required for a complete installation.

3. WATER SUPPLY SPECIALTIES

A. GENERAL

(1) Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in a neat and workmanlike manner in accordance with the manufacturer's recommendations and the State Plumbing Code.

(2) Where required by the State Plumbing Code, install code approved vacuum breakers in each water supply specialty.

B. FREEZEPROOF WALL HYDRANTS (FPWH)

(1) Provide code approved wall hydrants at each location indicated in a neat and workmanlike manner. Affix tight to walls and ensure that the feed piping is on the heated side of the building insulation blanket.

(2) Where hydrants are of handwheel type, remove handwheels and turn over to owners in an envelope labeled "Wall Hydrants" exterior upon completion of the project.

(3) Where hydrants have key operators, turn over at least two (2) keys in an envelope labeled "Wall Hydrants" to owners upon completion of the project.

(4) Where hydrants have lockable boxes, turn over at least two (2) keys in an envelope labeled "Wall Hydrants, Exterior" to owners upon completion of project.

(5) Mount all wall hydrants at least twenty (20) inches above finished exterior grade. Where this is not possible or practical, contact Engineers.

(6) Wall hydrants shall be as follows or equivalent:

a. Zurn 1300 or equivalent, 3/4", encased, flush, non-freeze wall hydrant with key lock and combination backflow preventer/vacuum breaker.

C. HOSE BIBBS (HB)

(1) Provide code approved hose bibbs with vacuum breakers and male threaded spouts at each location indicated and as follows:

(2) Do not install hose bibbs spaces which do not have existing planned or installed floor drains even if sill cocks are indicated for these areas.

(3) Hose bibbs shall be mounted at eighteen (18) inches above finished floor served.

(4) The hose bibb shall be Zurn or equivalent similar to the following:

a. Zurn Z1350-VB Model. Encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts, replaceable seat washer, screwdriver operated stop valve in supply, key operated control valve, and ¾ [19] IP female inlet and ¾ [19] male hose connection standard. Adjustable stainless-steel box furnished with hinged cover, cylinder lock and “WATER” stamped on cover. Provide with 3/4 adapter vacuum breaker.

D. BOILER DRAINS (BD)

Install 3/4-inch bronze body boiler drains, similar and equivalent to Nibco, No. 72 or 73, as indicated and at the following locations:

(1) At the low point of the plumbing system.

(2) On boiler low point.

(3) In each hot water heater and/or storage tank.

(4) At the low point of each hydronic system.

(5) On the water refrigeration machine (100 percent drainage).

(6) On each water storage tank.

(7) At each pump suction.

(8) At the low point of each isolatable section of any system carrying water.

NOTE: Install a code approved vacuum breaker where installation on to domestic water system.

E. WATER HAMMER ARRESTORS (WHA): Provide water hammer arrestors at each location indicated and/or as required to eliminate hydrostatic on the domestic water system. Provide at least one water hammer arrestor at all quick acting valve locations including:

Automatic Clothes Washers – Type “A”
Commercial Dishwashers – Type “B”
Sterilizers – Type “B”
Mop Basins (downstream of check valve) – Type “A”
Flush valve fixtures - Type “B” (Each toilet room with 1-3 flush valve fixtures shall have its own Type “B” water hammer arrestor.)

(1) Multiple Fixtures – Branch Line Less Than 20’ Long: The preferred location for a WHA is at the end of the branch line between the last two fixtures when the branch lines do not exceed 20’ in length, from the start of the horizontal branch line to the last fixture supply on this line.

(2) Multiple Fixtures – Branch Line More Than 20’ Long: On branch lines over 20’ in length, use two WHA’s whose capacities total the requirement of the branch. Locate one unit between the last and next to last fixture and the other unit approximately midway between the fixtures.

(3) Water hammer arrestors shall be PPP SC Series or equivalent. Water hammer arrestors shall be stainless steel, bellows type. Field fabricated capped cylinders shall not be acceptable.

(4) Note: Provide insulation unions where arrestors are of dissimilar material from the piping served.

MARK	MANUFACTURER & MODEL	SIZE	P.D.I. SIZE
TYPE "A"	PPP SC-500	1-11	A
TYPE "B"	PPP SC-750	12-32	B
TYPE "C"	PPP SC-1000	33-60	C
TYPE "D"	PPP SC-1250	61-113	D

F. PRESSURE REDUCING VALVES (PRV)

Install at each location indicated and/or as required to reduce domestic building water service to a maximum of eighty (80) PSIG code approved pressure reducing stations with by-pass. Install in a manner indicated or as required. Provide unions and stops for removal of station. PRV shall be adjustable from thirty (30) percent above or below reduced pressure. Where this cannot be attained with single stage, provide multi-staged reduction.

G. REDUCED PRESSURE BACKFLOW PREVENTERS (RPBP)

Watts #909 or equivalent reduced pressure backflow preventer. Provide with gate valves for isolation, FDA food grade strainer and air gap fitting. RPBP shall be UL listed.

H. DOUBLE CHECK VALVE ASSEMBLY

Watts #709, Watts #757, or equivalent double check valve assembly. Provide with FDA approved food grade strainer and gate valves for isolation. Assembly shall be UL listed.

4. GENERAL SPECIALTIES

A. VACUUM BREAKERS AND BACK FLOW PREVENTERS

Where required by the State Plumbing Code whether indicated or not, provide approved vacuum breakers or backflow preventers at the following locations.

(1) Where domestic water system connects to fire protection system.

(2) Where domestic water system connects to hydronic system.

(3) At any hose (threaded) tap on the domestic water system.

B. ROOF FLASHINGS

All plumbing vents or other plumbing passing thru the roof shall be flashed as approved by the State Plumbing Code and as recommended by the roofing manufacturer and/or Contractor.

C. GAS PRESSURE REGULATORS

Provide gas pressure regulators for all gas fired equipment. Regulators shall be installed in accordance with the requirements of NFPA 54 and/or International Fuel Gas Code, whichever is more stringent.

END OF SECTION 220100

SECTION 220200 - PLUMBING FIXTURES, FITTINGS AND TRIM

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. The Contractor shall provide all fixtures complete with trim required and connect in a manner conforming to the State Plumbing Code.

C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

D. All exposed piping or in casework below sinks, stops, traps, tailpieces, etc., shall be code approved chrome plated brass unless otherwise indicated or specified. Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws.

E. All fittings, fixtures and trim shall be new unless otherwise indicated or specified. They shall also be of equivalent quality, dimensions, material, etc. as those specified. All faucets, shower heads, drains, levers, trim, etc. shall be constructed of metal and not plastic.

F. Handicapped fixtures shall be mounted as recommended by the State Building Code and ADA.

G. All fixtures shall be mounted as recommended by the manufacturer. Fixtures shall be rigidly mounted to walls and floors. Pay particular attention to flush valves and bracket concealed portion to building structure during rough-in. Loose, shaky flush valves, lavatories, etc. shall not be acceptable.

H. Prior to final inspection open all faucets and allow to run for fifteen (15) minutes, then remove all faucet aerators and thoroughly clean until smooth flow is obtained.

I. Prior to final inspection, test by operation at least twice:

(1) (Where applicable) adequate flow of hot and/or cold water at;

a. Shower Heads
b. All Faucets
c. Flush Valves and Tanks
d. Tub Drains
e. Hose Bibbs
f. Sill Cocks
g. All Other Valved Hot and/or Cold-Water Openings in the Plumbing System

(2) All toilet seats

J. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from plumbing fixtures and thoroughly clean same.

K. All sink and lavatory traps shall have screw in plugs in the bottom for ease of cleaning and have mechanical fittings for ease of removal.

L. All fixtures shall be set level and true and shall be grouted into finished walls, floors, etc. in a neat and workmanlike manner with an approved waterproof non-yellowing grout for such service.

M. Special Note for Handicap Grab Rails: Coordinate top of shower valves, flush valves, flush tank, etc., with location of grab rails as shown on the architectural plans. The Contractor shall install all items to allow for installation, removal and service without removal of the grab bar.

N. All exposed drain pipes and domestic water piping under handicap accessible sinks and lavatories shall be insulated in accordance with ADA requirements and shall have a vinyl plastic covering over all insulation.

O. The Contractor shall obtain a copy of the casework shop drawings and confirm sinks, faucets, gas turrets, etc., will fit in the space provided. Additionally, in ADA applications with handicap sink base cabinets, the Contractor shall limit the total distance from the bottom of the sink to the bottom of the P-trap and coordinate waste pipe rough-in height to ensure the proper installation of the handicap sink base cabinet front closure panel. The Contractor shall not order sinks until he confirms no conflicts occur and shall adjust sink sizes if required. If the Contractor orders sinks, faucets, etc., that do not fit in the casework supplied, he shall replace them at no additional cost.

P. All lavatories, sinks, etc. shall be supplied with center rear drain outlets where necessary to avoid conflict with casework, handicapped kneeboards, etc. If the Contractor orders sinks that do not fit in the casework supplied, he shall replace them at no additional cost.

Q. All single supply faucets shall be provided with mechanical mixing valves unless otherwise noted. Mechanical mixing valves shall have hot and cold-water inlet connections, common outlet, in-line check valves, and adjustable temperature setting. Mixing valves shall be Moen model 104424 or equal. Provide one mixing valve per single supply faucet unless otherwise noted. Contractor shall provide all required connections and set mixing valve to required temperature.

R. All gooseneck faucets shall have rigid spouts, unless swing spouts are specified. If swing spouts are specified, the spout shall have a maximum swing of 140 degrees from side to side.

S. All plumbing fixtures shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

T. All water closet handles on ADA water closets shall be located on the approach side of the fixture.

2. FIXTURES AND TRIM

Available Manufacturers: Subject to compliance with requirements of manufacturers offering plumbing fixtures and trim. Plumbing fixtures and trim, which may be incorporated in the work include, but are not limited to, the following:

A. Plumbing Fixtures - Water Closet, Lavatory, Urinal, Bathtubs, Clinical Sink and Scrub Sink

American Standard, U.S. Plumbing Products
Eljer Plumbingware Div., Wallace-Murray Corp.
Kohler Co.
Crane Plumbing
Universal-Rundle
Toto
Zurn Co.
Sloan Fixtures

B. Plumbing Trim

American Standard, U.S. Plumbing Products
Chicago Faucet Co.
Kohler Co.
Delta Co.
T&S Brass & Bronze Work Co. (Commercial)
Zurn Co.
Just Co.
Speakman Co.
Moen Commercial

C. Flush Valves

Sloan Valve Co.
Zurn Co.
Approved equal; provide substitution information request to Engineer min. 10 days before bid date.

D. Fixture Seats

Bemis Mfg. Co.
Church Seat Co.
Olsonite Corp., Olsonite Seats

E. Water Coolers

Elkay Mfg. Co.
Halsey Taylor Div., King-Sealey Thermos Co.
Haws Drinking Faucet Co.
Western Drinking Fountains, Div. of Sunroc Corp.
Oasis Co.
Acorn AQUA

* Acceptable wall hung water coolers shall be equal to Oasis P8AM, Elkay EZS8 or Halsey Taylor HAC8FS. All other wall hung water coolers shall be subject to review of the Engineer.

F. Service Sinks and Mop Basins

American Standard, U.S. Plumbing Products
Eljer Plumbingware Div., Wallace-Murray Corp.
Fiat Products
Kohler Co.
Stern-Williams Co., Inc.
Florestone

G. Stainless Steel Sink

Elkay Mfg. Co.
Just Mfg. Co.
Moen, Div. of Stanadyne/Western
Sterling Co.

H. Fixture Carriers

Josam Mfg. Co.
Jay R. Smith
Tyler Pipe
Zurn Industries
Watts

I. Shower

Bradley Co.
Zurn Co.
Symmons Industries, Inc.
Chicago Faucets
Speakman Company
Powers
Acorn Co.
Moen Commercial

J. Shower Stalls

Clarion
Universal-Rundle
Aqua Bath
Aquarius
Aqua Glass
Acryline
Lasco Bathware

K. Washer/Dryer Connection Box

Guy Gray Co.
Wolverine Brass, Inc.

L. Emergency Fixtures - Eyewash, Showers

Bradley Co.
Speakman Co.
Guardian Co.

M. P-Trap Insulation Kit (Trap Wrap)

Truebro
Brocar
Plumberex

Note: Kitchen, Lab, Science Room Fixtures, Special Equipment, Etc.

Contractor to provide final plumbing connections to all of the equipment furnished by Owner including, but not limited to: chrome supplies, stops, continuous drains, drain tailpiece, Code compliant "P" traps and escutcheons.

3. FIXTURE SELECTION

A. Refer to drawings for fixture schedule.

END OF SECTION 220200

SECTION 220300 - PLUMBING EQUIPMENT

1. GENERAL

   A. All plumbing equipment shall comply with the latest provisions of KBC.

   B. Provide magnesium anodes for water heaters and storage tanks.

2. WATER HEATER

   A. Patterson Kelly or equivalent gas water heater; copper sheathed tin coated elements (75 watt/sq. in. maximum density); glass lined tank; foam insulation; magnesium anode rod; automatic over-heat control; enameled steel jacket; thermostat; 120/1/60; with ASME temperature and pressure relief valve; set temperature at 105°F. Refer to schedules on drawings for selections.

3. EXPANSION TANK (DOMESTIC WATER)

   A. Amtrol Therm-X-Trol expansion tank, pre-charged air chamber, stainless steel connection and heavy-duty butyl diaphragm. Refer to drawing's schedules for model number and tank size.

4. SUMP PUMPS

   A. ELEVATOR SUMP PUMPS (SP-1 & SP-2)

      (1) Weil, Zoeller, or approved equivalent submersible sump pump. Furnish with mercury switch level control. Provide with light duty iron grate to cover sump pit opening, completely. Refer to Schedule on drawings of selections.

   B. DUPLEX DEWATERING SUMP PUMP SYSTEM (SP-3)

      1. Two (2) Zoeller Model 6294; 480V volt 3 phase pump with 2" vertical discharge, 1.5 hp oil filled motor (4.8 FLA per pump), cast iron semi-open impeller, stainless steel shaft with tandem mechanical seals, thermal and seal fail sensors, powder coated epoxy cast iron housing, 25 foot power cord;

      2. Two (2) 2" guide rail assemblies consisting of base elbow, quick disconnect slide assemblies, and upper bracket. Sch. 40 stainless steel rail pipes,

      3. One (1) UL Listed 480-volt 3 phase duplex control panel with an electro-mechanical pump alternator, H-O-A toggle switches and run indicator lights for each pump, motor protector each pump three phase, high water alarm with light, horn and silence switch, control circuit transformer and breaker, and dry alarm contacts, all housed in a Nema 4X enclosure. Building management integration included.

      4. Includes three (3) 25' weighted, normally open mechanical float switches.

      5. One (1) 48" x 96" prefabricated fiberglass basin including anti-flotation flange, ¼" gas tight aluminum cover including a bolt down, gas tight access hatch, two (2) 2" discharge flanges, one (1) 3" vent flange, one (1) 10" inspection panel including 3 float cord grips for suspension of float switches; all internal discharge piping (2" Sch. 80 PVC), valves, fittings, guide rail assemblies, etc. are factory installed and one (1) 4" hub shipped loose for field installation of inlet.

      6. Start-up by factory representative once installation is complete.

5. RECIRCULATING DOMESTIC HOT WATER PUMPS

A. Thrush, Armstrong, Bell and Gossett or approved equivalent all bronze in-line centrifugal circulating pump with mechanical seals, drip proof motor and all required overloads, starters and disconnects. Refer to schedules on drawings for selections.

END OF SECTION 220300

SECTION 220400 - FUEL OIL STORAGE AND DISTRIBUTION SYSTEM

1. GENERAL

The Mechanical Contractor shall provide and install in strict compliance with all applicable codes and regulations and with manufacturer's recommendations, all components for a complete and functional Fuel Oil Storage and Distribution System as shown on the drawings or as specified herein, including, but not necessarily limited to the following:

A. Fuel oil storage tanks with all required appurtenances, connections, fill, vent, gauge sticks (1 per tank), etc.

B. All fuel oil supply, return, vent and fill piping.

C. Final connection of fuel oil supply piping to all fuel oil operated equipment: boilers, water heater and generator day tank, etc.

D. Fill all tanks and lines and perform initial equipment starts.

2. CERTIFICATIONS

The Contractor shall furnish the following notarized certifications to the Engineer upon completion of the appropriate phase of the work:

A. That the tank was surrounded with a minimum of 12" of pea gravel.

B. That an air test was performed and the installation found to be leak free.

C. That tank cover is 24" minimum.

D. That swing joints were used in the suction and return line at the tank.

E. That fuel oil lines were properly sleeved at floor, wall and foundation penetrations.

F. That the tank installation is sufficient to securely hold empty tanks in position.

3. FUEL OIL STORAGE TANKS

A. Furnish and install an underground steel storage tank with STI-P3 corrosion control system. Tank shall be in conformance with Underwriters Laboratories, Subject 58. Tank size as noted on drawings.

B. The corrosion control system shall be in strict accordance with STI-P3 specifications as applied by a licensee of Steel Tank Institute and shall have the STI-P3 limited twenty-year warranty against failure due to exterior corrosion. Tank shall bear UL and STI-P3 labels.

C. The tank excavation shall be free from material that may cause damage to the tank coating. Care shall be taken during installation that foreign matter is not introduced into the excavation or backfill.

D. The tanks shall be mounted on a concrete pad as shown on the drawings. That tank must not be placed directly on the pad. A layer of pea gravel, at least 12 inches deep, must be spread evenly over the dimensions of the pad to separate the tank from the pad.

E. Before placing the tank in the excavation, all dirt clods and similar foreign matter shall be cleaned from the tank, and areas of coating damages shall be repaired with a compatible coating.

F. Equipment to lift the tank shall be of adequate size to lift and lower the tank without dragging and dropping to ensure no damage to the tank or the coating. Tanks shall be carefully lifted and lowered by use of cables or chains of adequate length (not less than 45 degrees included angle) attached to the lifting lugs provided. A spreader bar should be used where necessary. Under no circumstances use chains or slings around the tank shell.

G. After the STI-P3 tank has been placed in the excavation, the anode lead wire attachment to the tank shall be checked to assure this connection has not been damaged. Where damaged, the connection must be re-established in strict accordance with STI-P3 specifications.

H. Hold Down Straps: Special care should be exercised when installing hold down straps to ensure that the straps are separated from the tanks by separating pad made of an inert insulating dielectric material. The separating pad should be at least 2 inches wider than hold down straps' width and must be carefully placed anywhere on the tank where hold down traps would come into direct contact with the tank shell.

I. Backfill consisting of pea gravel shall be placed along bottom sides of tank by shoveling and tamping to ensure the tank is fully and evenly supported around bottom quadrant. The backfill shall be deposited carefully around tank and to a depth over tank to avoid damage to coating.

J. The plugs at unused tank openings shall be removed, a pipe compound shall be added and the plugs shall be reinstalled in the unused openings. The dielectric bushings or flange isolation devices in STI-P3 tanks shall not be removed from openings. The plugs in tank openings which are to be used should not be overtightened as this may cause the bushing to unscrew with the plug. Care should be taken not to cross-thread or damage the non-metallic bushings when replacing plugs or installing required tank piping.

4. PIPE AND FITTINGS
   See Piping Section.

5. FUEL OIL SPECIALTIES
   By Oil Equipment Manufacturing Corp., Ohio Pattern Works, Sunstrand or Service Welding Company.

6. INSTALLATION
   Installation of Fuel Oil Storage and Distribution System shall comply with NFPA-30 of the National Fire Protection Code. (NFPA).

END OF SECTION 220400

SECTION 220600 - MEDICAL GAS PIPING SYSTEMS

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the NFPA and all other applicable codes.

   C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc., as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

   D. All equipment and specialties shall be new unless otherwise indicated or specified. They shall also be of equivalent quality, dimensions, materials, etc., as those specified.

   E. All equipment and specialties shall be installed as recommended by the manufacturer.

   F. All equipment and specialties shall be installed in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.

   G. Refer to applicable Division 26 sections for wiring and power.

2. DESCRIPTION OF WORK

   A. Extent of medical gas piping system work is indicated on the drawings and by requirements of this section.

   B. NFPA Compliance: Comply with requirements of NFPA Standard 99 Gas and Vacuum Systems. All portions of each system shall be listed by and bear the seal of UL, Inc., where a standard has been established for such.

   C. Comply with ANSI/AWS A5.8 - Specifications for Brazing Filled Metal regarding pipe joint make-up.

   D. Central Medical Gas and Vacuum Systems: Consisting of Oxygen, Nitrous Oxide, Nitrogen, Medical Air, Vacuum and Anesthesia Evacuation Services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets and inlets, equipment connections, rough-ins, ceiling services, gauges, alarms, headwall units, including low voltage wiring, nitrogen control panels, air compressors, vacuum pumps, electric motors and starters, receivers, air dryers, filters, pressure regulators, and all necessary parts, accessories, connections and equipment. Match station outlets and inlets.

   E. Related Work

      (1) Sealing around pipe penetrations to maintain the integrity of time rated construction.

      (2) Sealing around pipe penetrations through the floor and roof to prevent moisture migration.

      (3) Piping systems identification.

(4) Exposed piping and sleeves, and water piping, controls and accessories.

(5) Surgical service multi-purpose pendant.

(6) Alarm interface with main hospital alarm panel.

(7) Conduit.

(8) Control wiring.

(9) Electrical wiring and accessories.

(10) Electric motors.

(11) Motor starters.

(12) Prefabricated bedside patient units.

F. Quality Assurance

(1) Materials and Installation: In accordance with NFPA 99, and as specified.

(2) Equipment Installer: Show technical qualification and previous experience in installing medical gas equipment on three similar projects.

(3) Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project, that has been in satisfactory and efficient operation for three years.

(4) Independent Medical Gas System Testing Organization:

a. Testing agency that is financially independent of medical gas equipment manufacturer and supplier.

b. Provide names of three projects where testing of medical gases and systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.

c. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequences, procedures for cross connection, tests, outlet function tests, ceiling column function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.

(5) Certification: Provide documentation upon completion of the testing to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this section.

3. DRAWINGS AND DESCRIPTIVE LITERATURE

The Contractor shall prepare and submit to the Architect and/or Engineer, seven (7) copies of shop drawings including, but not limited to, the following list:

A. Manufacturer's Literature and Data

(1) Piping.

(2) Valves.

(3) Gauges.

(4) Switches (pressure and vacuum).

(5) Air compressor systems. (Provide certified compressor test data at start-up):

a. Compressor: Manufacturer and model.

1) Characteristic performance curves.

2) Compressor operating speed (RPM).

b. Capacity: Free air delivered at indicated pressure (SCFM).

1) Type of bearing in compressor.

2) Type of lubrication.

3) Type and adjustment of drive.

c. Electric Motors: Manufacturer, frame and type.

1) Speed of motors (RPM).

2) Current characteristics and horsepower of motors.

3) Receiver capacity and rating.

4) Control panel operational characteristics and wiring diagram.

d. Air Silencer: Manufacturer, type and model.

e. Air Filters: Manufacturer, type, model and capacity.

f. Pressure Regulators: Manufacturer and capacity.

g. Dew Point Monitors: Manufacturer, type and model.

h. Air Dryers: Manufacturer, type, model and capacity (SCFM).

i. Alarm Controls and Panels: Manufacturer, type and accessories.

(6) Vacuum Pump Systems (Provide certified pump test data at start-up):

a. Pumps: Manufacturer and model.

1) Pump performance curves.

2) Pump operating speed (RPM).

b. Capacity: Free air exhaust from 19 and 24 inches Hg. gauge vacuum (SCFM).

c. Capacity: Expanded air capacity at 19 and 24 inches Hg. gauge vacuum (ACFM).

1) Type of bearing in pump.

2) Type of lubrication.

3) Type and adjustment of drive.

d. Electric Motors: Manufacturer, frame and type.

1) Speed of motors (RPM).

2) Current characteristics and horsepower of motors.

3) Receiver capacity and rating.

4) Control panel operational characteristics and wiring diagram.

e. Silencers: Manufacturer, type and model.

B. Applicable Publications

(1) The publications listed below form a part of this specification to the extend referenced. The publications are referenced in the test by the basic designation only.

(2) Federal Specifications (Fed. Spec.):

WW-V-35C.....Valve, Ball

(3) American National Standards Institute (ANSI):

B16.22-89 .....Wrought Copper and Bronze Solder-Joint Pressure Fittings

B-40.1-85 .....Gauges-Pressure Indicating Dial Type-Elastic Element

(4) American Society for Testing and Materials (ASTM):

B88-88.....Seamless Copper Water Tube

B280-88.....Seamless Copper Tube for Air

(5) American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code

Section VIII.....Pressure Vessels, Division I

(6) American Welding Society (CGA):

G-10.1-85.....Nitrogen, Commodity

P-9-80 .....Inert Gases Argon, Nitrogen and Helium

V-5-78 .....Diameter Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications)

(7) National Electrical Manufacturers Associations (NEMA):

ICS-6-83.....Enclosures for Industrial Control Systems

(8) National Fire Protection Association (NFPA):

99 .....Gas and Vacuum Systems

(9) United States Pharmacopeia XXI/National Formulary XVI (USP/NF)

(10) National Association of Architectural Metal Manufacturers (NAAMM):

Metal Finishes Manual

4. MEDICAL GAS PIPING MATERIALS AND PRODUCTS

A. General

Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated on drawings. Provide materials and products complying with the latest NFPA 99. Provide fittings of materials which match pipe materials used in medical gas piping systems including equipment connection.

(1) Piping shall be hard-drawn seamless medical gas tube, Type K or L (ASTM B819), and bear one of the following markings: OXY, MED, OXY/MED, ACR/OXY, or ACR/MED. Mains and branches in piping systems shall be not less than 1/2 in. nominal size. Runouts to area alarm panels shall be permitted to be 1/4 in. nominal size.

(2) Brazing Alloy: Provide brazing that complies with the latest NFPA 99 Gas and Vacuum Systems.

(3) Threaded Joints: Provide threaded joints that complies with the latest NFPA 99 Gas and Vacuum Systems.

(4) Identification: The gas content of medical gas piping systems shall be readily identifiable by appropriate labeling with the name of the gas contained. Such labeling shall be by the means of metal tags, stenciling, stamping or with adhesive markers in a manner that is not readily removable. Labeling shall appear on the piping at intervals of not more than 20 ft (6 m) and at least once in each room and each story traversed by the piping system. Where supplementary color identification of piping is used, it shall be in accordance with the gases and colors indicated in CGA Pamphlet C-9, Standard Color-Marking of Compressed Gas Cylinders Intended for Medical Use.

(5) General Requirements for Central Supply Systems:

a. Piping systems, with the exception of nitrogen systems, shall be capable of maintaining 50-55 psig (345 380 kPa gauge) to all outlets at the maximum flow rate.

b. Piping systems that vary from the normal 50-55 psig (e.g., systems supplying gas to hyperbaric chamber or for driving medical tools), shall be capable of delivering at flows and pressures consistent with their intended use.

c. A nitrogen system shall be capable of delivering at least 160 psig (1.1 MPa gauge) to all outlets at maximum flow.

B. Basic Piping Specialties]

(1) General

Provide piping specialties complying with the latest NFPA 99 in accordance with the following listing:

a. Pipe Escutcheons.

b. Pipe Sleeves.

c. Sleeve Seals.

C. Basic Supports, Anchors and Seals

(1) General

Provide supports, anchors and seals complying with Division 48 in accordance with the following listing:

a. Adjustable swivel pipe rings for horizontal piping hangers and supports.

b. Two-bolt riser clamps for vertical piping supports.

c. Concrete inserts, C-clamps, and steel brackets for building attachments.

5. MEDICAL GAS SYSTEM COMPONENTS

A. General

Furnish and install per latest NFPA 99 requirements a complete oxygen, vacuum, medical air nitrous oxide, nitrogen, vacuum system, carbon dioxide systems, etc., including, but not limited to, the following list:

(1) Gauges

a. Pressure Gauges: Includes gauges temporarily supplied for testing purposes.

1) For Line Pressure Use Adjacent to Source Equipment: ANSI B40.1, pressure gauge, single, size 4-1/2, for compressed air, nitrogen and oxygen, accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on white background, or white on a black background. Gauge shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL." Install with gaugecock.

2) For All Services Downstream of Main Shutoff Valve: Manufactured expressly for oxygen use but labeled for appropriate service and marked "USE NO OIL," 1-1/2-inch diameter gauge with dial range 1-100 psig for oxygen, nitrous oxide and air, and 1-300 psig for nitrogen service.

b. Vacuum Gauges:

1) For vacuum line use adjacent to source equipment: ANSI B40.1, vacuum gauge, size 4-1/2" gauge for air, accurate to within two percent, with metal case. Range shall be 0-30 inches Hg. Dial graduations and figures shall be black on a white background, or white on a black background. Label for vacuum service. Install with gaugecock.

2) For vacuum service upstream of main shutoff valve: Provide 1-1/2-inch diameter gauge with steel case, Bourdon tube and brass movement, dial range 0-30 inches Hg.

c. All gauges shall be manufactured by Beacon Medaes, Powerex, Amico or equivalent.

(2) Pressure and Vacuum Switches and Relief Valves

a. General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements.

b. Each central supply system shall have a pressure relief valve set at 50% above normal line pressure, installed downstream of the pressure regulator and upstream of any shutoff valve. This pressure relief valve may be set at a higher pressure provided another pressure relief valve set at 50% above normal line pressure is installed in the main supply line. All pressure relief valves shall close automatically when excess pressure has been released. Pressure relief valves set at 50% above normal line pressure shall be vented to the outside if the total capacity of the supply system is in excess of 2000 cu ft (57 m3) of gas. Pressure relief valves shall be of brass or bronze and especially designed for the gas service involved.

c. The pressure relief valve downstream of the line pressure regulator in nitrogen systems, used to provide power for gas-drive medical tools, instruments, or other systems, that vary from the normal 50-55 psig (345-380 kPa gauge) line pressure (i.e., systems supplying medical gases to hyperbaric chambers), shall be set at 50 percent above line pressure or 200 psig (1.4 MPa gauge), whichever is lower.

d. All pressure and vacuum switches shall be manufactured by Beacon Medaes, Powerex, Amico or equivalent.

(3) VALVES

a. General

1) All valves shall comply with the latest NFPA 99 Gas and Vacuum Systems.

b. Ball

In line, other than zone valves in cabinets.

1) Three Inches and Smaller: Fed. Spec. WW-V-35, Type II, Class A, Style 1, with brazed connections. Three-piece, Buna-N or teflon seat seals, full flow, 300 psig minimum working pressure, with locking type handle.

c. Check

1) Three Inches and Smaller: Brass body, self-aligning, spring loaded ball type check mating with teflon cone seat.

(4) Medical Air Compressor Systems

a. Medical air compressors provide compressed air for patient use only. All components shall be provided by and the responsibility of one manufacturer and shall be factory packaged (pre-wired and pre-piped) on a steel base, or tank mounted. Completed system installation shall provide medical air quality equal to or better than the quality specified under ANALYSIS, TESTS.

b. Compressors: Provide quality of air equal to or better than the quality of the intake air, without the use of purification equipment. Multiplex such that design load is provided with the largest single unit out of service; design piping, accessories and controls to withstand 150 psig. Provide each compressor with automatic check valves as required for proper operation and the prevention of loss of pressure through the compressor. Provide manual shut-off valve downstream of the check valve for service to check valve and compressor without total system shutdown.

1) Reciprocating Type: Capable of delivering a minimum pressure of 125 psig, without oil lubrication, with bearings packed with non-petroleum based product and sealed for lifetime lubrication; piston compression and guide rings and piston skirts warranted for minimum 8,000 operating hours; rated for continuous dry, 24 hours per day, seven days per week.

c. Motor and Starter: Maximum 40EC ambient temperature rise motor, ball or roller bearing. Open drip proof construction, continuous duty rated with service factor of 1.15 or greater; sufficient capacity to drive compressors without exceeding the nameplate rating of the motor. Provide each motor with automatic, fully enclosed, magnetic starter or type specified in other specification sections.

d. Controls:

1) Automatic: Adjustable, pressure operated, automatic, electric switch to start and stop motor at receiver pressure indicated. Provide heavy duty alternator, automatic, operating on a timed basis, to alternate the compressors by time forced alliteration.

2) Unloading: Automatic device, to unload compressor under all startup conditions including following current failure while operating, as well as protect against receiver backpressure.

3) Control Panel: Housed in a NEMA ICS-6, Type 12 listed, dustproof enclosure; prewired to include all specified electrical, electronic and electro-pneumatic devices. Include wiring diagrams and operating descriptions in the cabinet. Include the following:

(a) Circuit breaker for each control and motor circuit.

(b) Hand-off automatic selector switch for each compressor.

(c) Hour meter for each compressor.

(d) Control circuit transformers.

(e) Magnetic motor starter for each compressor.

(f) Provide panel with external visual (lights: red for running, green for safe) and audible (horn/buzzer) signals. The signals provided include:

i. Compressor in operation (visual only).

ii. High temperature shutdown (visual and audible), with contacts for connections to external alarm.

iii. High receiver water level shutdown (visual and audible) with contact for connections to external alarm.

iv. Cancel button, which will silence an audible alarm, reactivate should a second alarm occur while the audible is silenced and reset automatically upon correction of the original condition.

(g) Complete panel assembly shall be UL listed.

e. Receiver Tank: Welded steel, galvanized, in compliance with ASME Section VIII, 125 psig working pressure stamped and certified. Equip with safety relief valve set at 120 psig, float type automatic drain, sight glass and pressure gauge. Provide receiver of sufficient capacity to ensure practical on/off operation of compressors.

f. Air Silencer: Finned dry type inlet filter/muffler, enclosed in a housing allowing easy removal of the element for inspection of replacement, with a nominal retention of 10 microns or less and muffling by a series of silencer tubes. Provide filter of sufficient size to minimize back pressure.

g. Air Filters: Provide duplex outlet filter sets, piped in parallel and provided with valves to bypass each filter set for element replacement without system shutdown. Size each filter set for no greater than five psig differential pressure switch, designed to withstand full line pressure on either side of diaphragm without damage, to indicate when pressure drop across filter sets rises to more than two psig above when clean and new. Wire switch to the master alarm panel.

1) Rough Filters: Maximum five-micron, 98% efficiency retainage.

2) Final Filters: For reciprocating compressors, coalescing type, 0.03 micron or less absolute retainage. For liquid ring compressors, 0.1 micron or less, 98% efficiency retainage.

(a) Odor and Taste Removal Filter: Activated charcoal, downstream of each final filter.

h. Pressure Reducing Regulators: Provide duplexed in parallel, valved for maintenance shutdown without service interruption. Brass or bronze body and trim, reduced pressure rang 0-125 psig adjustable, piston type, pilot operated, relieving. Delivered pressure shall vary not more than 1 psig for each 10 psig variation in inlet pressure.

i. Dew Point Monitor: With digital or gauge type display, locate sensor in the pipeline downstream of regulators for continuous monitoring at line pressure. Install with valved, normally closed by-pass to allow disconnection without system shutdown. Provide local non-cancelable visual and cancelable audible alarm and a signal to the master alarm panels to operate when pressure dew point rises above 39EF at 55 psig.

j. Air Dryer: Duplexed, each sized for 100% of design load, self-contained, refrigerated type, with counter current heat exchanger, hermetically sealed refrigeration system, moisture separator with automatic drain and all internal wiring and plumbing. House unit in factory standard corrosion resistant cabinet with access doors or panels as required for ease of service and maintenance. Dryer shall be capable of providing 35EF (2EC) pressure dewpoint at 100 psig inlet pressure, 100EF inlet temperature and 100EF inlet dewpoint under full load conditions and be properly sized to produce 35EF or better pressure dewpoint under full load at site conditions.

k. Special Requirements:

1) For Reciprocating Type Compressors:

(a) High temperature shut-down sensor, immediately downstream of the compressor discharge, to sense discharge air temperature above 350EF and shutdown affected unit. Provide visual and audible alarms and compressor circuit reset button on control panel, with contact for external signal. Wire to master alarm panel.
(b) Aftercooler: Water-cooled, with solenoid valve for cooling of airstream before it enters receiver tank. Provide water controls.

l. Warranty

1) Bare pump will be warranted 30 months from startup or 36 months from shipment, whichever comes first.

2) All other components will be warranted 12 months from startup or 18 months from shipment, whichever comes first.

m. All medical air compressor shall be manufactured by Powerex, Beacon Medaes, Amico or equivalent.

(5) Vacuum Pump Systems:

a. Claw Vacuum Pump Each pump shall be a rotary claw type vacuum pump, and shall be direct-driven through a shaft coupling by a C-face, TEFC electric motor.

b. Each vacuum pump shall be dry-running, featuring two claw-type, non-contacting rotors and shall not require any sealing fluid in the pumping chamber, assuring virtually maintenance-free operation.

c. Each vacuum pump shall include an internal relief valve, and a built-in, anti-suck-back valve mounted at the pump inlet.

d. Each pump within the system shall include a check valve, inlet and discharge flex connectors, a 5 micron inlet filter and a pump isolation valve.

e. Motor: The motor is continuous duty, C-face, TEFC, suitable for 208-230, or 460V, 3 phase, 60 hertz electrical operation.

f. Air Receiver: The system shall include an ASME rated air receiver. The tank shall be equipped with a vacuum gauge, a sight gauge, by-pass valves, and a manual drain.

g. VFD Control Panel: Variable Frequency Drive (VFD) control improves efficiency over a conventional “on/off” demand based system by more closely matching the pump speed to the changing load requirements. All VFD systems come standard with a Premium NFPA Control panel. The VFD and Premium NFPA Control Panel shall include a gateway server card and all features listed below:

1) PLC controller and a color touch screen panel which displays the operating status of the unit.

2) Building automation communication gateway with BacNet® protocol and Web server features. Web server s features include email notifications in case the system is in alarm or has achieved one its maintenance intervals and requires service.

3) Ethernet port for connection to BacNet® server or direct connection to facility Ethernet for viewing of system operations and status via device IP-address.

4) UL508A listed control panel in a NEMA 12 enclosure. The panel door will include: the HMI touch screen, an audible and visual alarms with an acknowledge button, VFD start/stop switch and an HOA switch for each pump.

5) Magnetic starters.

6) Vacuum transducer for process control.

7) Single point power connection.

8) Redundant 120Vac control transformers with fused primary and secondary protection.

9) System overload trip, high temperature conditions or maintenance intervals for the pump will result in visual and audible alarms.

h. Additional Requirements Options

1) Oxygen assured pumps - prepared for use in WAGD systems.

2) Internal tank lining for corrosion resistance.

3) Variable Frequency Drive (VFD) Control Panel – with Premium NFPA controls.

(6) Bulk Medical Gas System

(7) Cylinder Supply System with Reserve Supply

(8) Manifolds

(9) Pressure Regulator

(10) Pressure Relief Valve

(11) Changeover Actuating Switch

(12) Line Pressure Regulator

6. PURGING

A. After all medical gas piping systems have been tested, the source of the test gas shall be disconnected and the proper gas source of supply connected to each respective system. Following this connection and pressurization, all outlets shall be opened in a progressive order, starting nearest the source and completing the process of purge flushing at the outlet farthest from the source.

B. Purge gas shall be allowed to impinge upon a white cloth material at a minimum flow rate of 100 liters per minute until no evidence of discoloration is evident and the test gas used during the previous tests has been removed from the piping systems.

7. ANALYSIS

A. After completing the purge flushing of the piping in accordance with the latest NFPA 99, the flow of gas from each station outlet for oxygen, mixed gases containing oxygen and medical compressed air shall be tested with an oxygen analyzer to confirm the presence of the desired percentage of oxygen.

NOTE: Testing of outlets for other gases to confirm the presence of the designated gas is also required.

(1) Where mixtures are piped that involve a low concentration of one component, such as 95% oxygen and 5% carbon dioxide, an analyzer must be used having sufficient accuracy to properly indicate the mixture. This, in some cases, may require an analyzer specific to each component.

(2) The test specified in the latest NFPA 99, shall be conducted on the downstream portions of the medical gas piping system whenever a system is breached and whenever modifications are made or maintenance performed in anesthetizing locations or vital life support or critical area.

The only test required when the oxygen (pure or mixed) or medical compressed air portion of an existing piped medical gas system is repaired is an analysis test to assure that no cross-connection of gases has been created. This may seem unnecessary when replacing a broken outlet or zone valve, but it is very important to document that the correct gas is flowing out of a labeled outlet. There can be no compromises in patient safety with respect to gases that will be inhaled by patients.

Once verification and analysis have been conducted on a new or modified of a system, it does not have to be repeated until the system is again breached or modified.

B. Prior to the connection of any work to the systems, all tests shall be successfully performed. After connection to the systems and before use for patient care, the tests in the above sections shall be successfully completed.

C. The final connection shall be leak tested with the source gas at the normal operating pressures. This pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen.

8. INSTALLATION AND TESTING OF MEDICAL GAS SYSTEM

A. In accordance with the latest NFPA 99

Before installation, all piping, valves, fittings and other components for all nonflammable medical gas systems shall be thoroughly cleaned of oil, grease and other readily oxidizable materials as is for oxygen service. After cleaning, particular care shall be exercised in the storage and handling of such material. Such material shall be temporarily capped or plugged to prevent recontamination before final assembly. Just prior to final assembly, such material shall be examined internally for contamination and shall be recleaned if necessary.

(1) Piping, valves, fittings and other components may be especially prepared in a facility equipped to clean, rinse and purge the material in accordance with the requirements of the latest NFPA 99 or may be prepared on the job site in accordance with NFPA 99. Trichloroethylene shall not be used in any cleaning operation at the job site. Carbon tetrachloride shall not be employed in any cleaning operation.

a. Piping, valves, fittings and other components that have been especially prepared shall have been cleaned in accordance with the provisions of CGA Pamphlet G-4.1, Cleaning

Equipment for Oxygen Service. Such material shall be delivered capped or plugged and shall be inspected prior to final assembly as required in the latest NFPA 99. If necessary, recleaning shall be done in accordance with NFPA 99.

b. Piping, valves, fittings and other components prepared at the job site shall be cleaned by washing in a hot alkaline cleaner-water solution, such as sodium carbonate or trisodium phosphate (proportion of one pound to three gallons of water). Scrubbing shall be employed where necessary to ensure complete cleaning. After washing, the materials shall be thoroughly rinsed in clean, hot water.

B. Comply with other specification section for exposed piping and sleeves.

C. Keep open ends of tube capped or plugged at all times. Wash and rinse unplugged, partially completed piping system in accordance with Article, Cleaning of Piping, Valves and Fittings.

D. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or remaining of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, rewash affected items in accordance with Article, Cleaning of Piping, Valves and Fittings.

E. Spacing of Hangers: Shall comply with the latest NFPA 99, but shall in no case be greater than 10 feet.

F. Rigidly support valves and other equipment to prevent strain on tube or joints.

G. Take care not to anneal copper tube while brazing. Braze only while purging the interior tube with nitrogen, minimum U.S.P. or Grade B as specified in CGA G-10.1.

All brazed joints in the piping shall be made up using brazing filler allows that bond with the base metals being brazed and that comply with Specification for Brazing Filler Metal, ANSI/AWS A5.8 and the latest NFPA 99.

H. Do not bend tubing. Use fittings.

I. Install pressure and vacuum switches to be easily accessed and provide access panel where installed above plaster ceiling.

J. Apply pipe labeling during installation process and not after.

K. Pipe compressor intake to a source of clean ambient air as indicated in the latest NFPA 99.

L. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency perform final tests complying with the latest NFPA 99.

M. Penetrations

(1) Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floor, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as

specified in other sections. Completely will and seal clearances between raceways and openings with the fire stopping materials.

(2) Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in other sections.

9. CERTIFICATION AND TESTS

A. Cross connection certification shall be the responsibility of the Contractor and shall be as follows:

(1) Cross-connection testing and certification of the medical-gas system shall be performed by medical gas testing agency.

(2) Medical-gas system shall be tested in accordance with the latest NFPA 99.

(3) In addition to cross-connection testing, this specification shall require the medical gas testing agency to test each individual pipeline system component for performance to design specifications and the Contractor make any necessary adjustments to ensure a complete and working system.

(4) In the event the cross-connection test indicates contaminated or cross connected medical gas systems, it shall be the responsibility of the Contractor to correct the problems at no additional cost to the Owner. This procedure shall be repeated until the cross-connection test proves positive and is hence certified.

B. Tests

(1) Initial Tests: Blowdown, and high and low-pressure leakage tests as required by the latest NFPA 99, with documentation.

(2) Medical Gas Testing Agency Shall Perform the Following:

a. Perform and document all cross-connection tests, labeling verification, supply system operation and valve and alarm operation tests as required by and in accordance with NFPA 99 and the procedures set for in prequalification documentation.

b. Verify that the systems, as installed, meet or exceed the requirements of NFPA 99 and this specification and that the systems operate as required.

c. Piping Purge Test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 3.5 cubic feet (100 liters) of gas through a clean white 0.45-micron filter at a minimum velocity of 3.5 scfm (100 1pm). Filter shall show no discoloration and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas a described in CGA P-9.

d. Piping Purity Test: For each positive pressure system, verify purity of piping system. Test each zone at the most remote outlet for dew point, carbon monoxide, total hydrocarbons (as methane) and halogenated hydrocarbons and compare source gas. The two tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Perform test with the use of an inert gas.

e. Source Contamination Test: Analyze each pressure gas source for concentration of contaminants, by volume. Take samples for air system test at the intake and at a point immediately downstream of the final filter outlet. The compared tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Allowable concentrations are below:

1) Dew Point: Air - Minus 18°C atmospheric
All Others - Minus 45°C atmospheric

2) Carbon Monoxide: - 10 ppm

3) Carbon Dioxide: Air - 1000 ppm
All Others - 300 ppm

4) Gaseous Hydrocarbons: Air - 5 ppm (as methane)

5) Halogenated Hydrocarbons: Air - 2 ppm

f. Analysis Test:

1) Analyze each pressure gas source and outlet for concentration of gas, by volume.

2) Make analysis with instruments designed to measure the specific gas dispensed.

3) Allowable concentrations are within the following:

(a) Oxygen - 99(+)% Oxygen

(b) Nitrous Oxide - 99(+)% Nitrous Oxide

(c) Nitrogen - Less than 1% Oxygen or 99(+)% Nitrogen

(d) Medical Air - 19.5% to 23.5% Oxygen

g. Maximum Allowable Variation: Between comparative test results required as follows:

1) Dew Point - 2°C

2) Carbon Monoxide - 2 ppm

3) Total Hydrocarbons as methane - 1 ppm

4) Halogenated Hydrocarbons - 2 ppm

END OF SECTION 220600

SECTION 230100 - PUMPS

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Provisions - Mechanical and to all other contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the specifications which affect the work of this section and which are hereby made a part of the work specified herein.

B. All required motor starters shall be furnished with the respective pump.

C. Electric motors shall be furnished with the pumps and shall be of the size and type scheduled or otherwise specified. All motors shall be UL labeled and shall comply with applicable NEMA standard.

D. Shop drawings shall be submitted as required by Section 200300 and shall include complete pump specifications, installation and start-up instructions, current and accurate pump performance curves with the selection points clearly indicated, maintenance data and spare parts lists.

E. Pumps shall be factory tested, cleaned and painted prior to shipment. Size, type, capacity and electrical characteristics are listed in the pump schedule.

F. Insofar as possible, all pumps shall be by the same manufacturer.

G. Pump shall have data plate indicating horsepower, voltage, phase, ampacity, pressure head, and flow rate.

H. Special notes for pumps controlled by variable frequency drives:

(1) Supplier shall provide the largest non-overloading impeller size for the specified pump motor horsepower, regardless of the specified pump head given on the pump schedule(s).

(2) Pumps less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer’s instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer’s instructions. Install kit in strict accordance with manufacturer’s instructions.

(3) Pumps greater than 100 HP to 1000 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. Provide shaft grounding ring on drive end and non-drive end of motor per manufacturer’s instructions. Additionally, provide insulated bearing journals to further reduce risk of current dissipation through bearings. Ground motor frame per manufacturer’s instructions. Install kit in strict accordance with manufacturer’s instructions.

2. MATERIAL

A. BASE MOUNTED PUMPS

(1) Type: Horizontal, base mounted, end suction, single stage, flexible coupled, 175 PSI working pressure.

(2) Pump Body: Cast iron, flanged gauge and drain tappings, bronze fitted.

(3) Shaft: Stainless steel. Refer to special notes for pumps controlled by VFD's above for shaft grounding kit specification.

(4) Bearing: Re-lubricatable ball bearing. Provide insulated bearing journals for pumps greater than 100 HP.

(5) Seal: Mechanical, carbon ring with ceramic seal.

(6) Motor: open, drip proof, re-lubricatable ball bearing. Minimum efficiency per NEMA Premium Induction Motor Efficiency.

(7) Impeller: Enclosed, balanced.

(8) Base: Structural steel.

(9) Coupling: Flexible with coupling guard.

(10) Manufacturers: Subject to compliance with the specified and scheduled requirements. Pumps by the following manufacturers will be considered:

Armstrong/Aurora
Bell and Gossett
Patterson
Taco

(11) SELECTIONS:

Refer to the schedule on the plans for base-mounted pump selections.

B. CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(a) Armstrong Pumps Inc.
(b) Bell & Gossett.
(c) Patterson Pump Co.
(d) TACO Incorporated.

2) Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

3) Pump Construction:

(a) Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.

(b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
(c) Pump Shaft: Stainless steel.
(d) Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and bellows and gasket. Include water slinger on shaft between motor and seal.
(e) Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
(f) Pump Bearings: Oil lubricated; bronze-journal or thrust type.

4) Motor: Single speed and rigidly mounted to pump casing.

(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 designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

i. Enclosure: Open, dripproofRetain "Enclosure Materials," "Motor Bearings," "Unusual Service Conditions," "Efficiency," "NEMA Design," and "Service Factor" subparagraphs below if options are available from pump manufacturers and are different from default requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." Consider each subparagraph and retain only those that vary from default requirements.
ii. Enclosure Materials: Cast iron
iii. Motor Bearings: grease-lubricated ball bearings.

3. EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment bases.

1. Coordinate sizes and locations of concrete bases with actual equipment provided.

2. Construct bases to withstand, without damage to equipment, seismic force required by code.

3. Construct concrete bases 4 inches (100 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or unless required for seismic-anchor support.

3.3 ALIGNMENT

A. Engage a Reliable Manufacturing Implementation Certified (RMIC) certified representative to perform vibration analysis and alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

6. Start motor.

7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 230100

SECTION 230200 - HVAC EQUIPMENT AND HYDRONIC SPECIALTIES

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide in complete working order the following heating, ventilation and air conditioning equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.

C. Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer’s Checklist.

D. Factory startup is required for all HVAC equipment. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. This shall include air handling units, boilers, chillers, cooling towers, VFDs, etc.

E. All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90 and/or International Energy Conservation Code 2012, whichever is more stringent.

F. Installation of all heating, ventilating and air conditioning systems shall be performed by a master HVAC contractor licensed in the state the work will be performed.

G. Note to Suppliers and Manufacturers Representative furnishing proposals for equipment for the project:

(1) Review the Controls Section of these Specifications (if applicable) to determine controls to be furnished by the equipment manufacturer, if any. The Contractor shall provide all controls with equipment unless specifically listed otherwise.

(2) Review the section of these specifications entitle: SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.

(3) Ensure that the equipment which you propose to furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.

(4) Determine from the Bid Documents the date of completion of this project and ensure that equipment delivery schedules can be met so as to allow this completion date to be met.

(5) Where manufacturers’ temperature controls are specified, they shall be in full compliance with International Mechanical Code Section 606 including automatic smoke shut down provisions.

(6) Provide factory start-up on site by a factory representative (not a third-party contractor) for all HVAC equipment, including pumps, VFDS, boilers, chillers, cooling towers, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer.

(7) Provide training to the Owner by a factory representative for each type of equipment. Training shall be a minimum of eight (8) hours on site and the Engineer shall be notified one (1) week in advance of the training. Training shall only occur when the systems are complete and 100% functional. All training shall be video taped.

(8) Review the Section on Motor Starters and Electrical Requirements for Mechanical Equipment.

(9) Requirements for motors controlled by variable frequency drives:

a. All motors shall be inverter duty rated.

b. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

c. Motors greater than 100 HP to 1000 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. Provide shaft grounding ring on drive end and non-drive end of motor per manufacturer's instructions. Additionally, provide insulated bearing journals to further reduce risk of current dissipation through bearings. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

(10) Type 1 kitchen exhaust hoods shall be provided with a heat sensor per IMC 2006, section 507.2.1.1, to enable the exhaust and make-up air system automatically upon detection of heat.

(11) Equipment incorporating energy recovery wheels shall be provided with an aluminum wheel with molecular sieve desiccant, 4 angstrom maximum sieve size. Wheels shall be certified in accordance with ASHRAE 84 or ARI 1060 standards.

(12) All condensate producing equipment shall be provided with a condensate trap as recommended by the equipment manufacturer and a condensate overflow switch.

(13) Provide low ambient and all required controls and accessories on all HVAC equipment to ensure they can provide cooling during the winter season.

(14) All outdoor HVAC equipment shall be provided with hail guards.

(15) Provide a complete air tight enclosure with opening door that seals air tight for all filters on air moving equipment.

(16) All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

2. EQUIPMENT

A. VENTILATING FANS

(1) Ventilating fans shall be of the type, capacity, size, etc. here-in-after scheduled. Catalog numbers are listed as design criteria only. Alternate selections will be accepted provided quality,

function, etc. are equivalent. All fans shall be UL listed, complete with all required disconnects and starters and shall be AMCA rated and certified. Model numbers listed are Greenheck, acceptable alternates are Penn, Carnes, Acme, Shipman, Jenn-Aire and Loren-Cook. The Architect shall select the color for all exposed fans.

(2) Selection

Refer to the schedule on the plans.

B. HYDRONIC SPECIALTIES

(1) Manufacturers

Subject to compliance with the specified and scheduled requirements the following manufacturers will be considered, but not limited to:

Hoffman
Amtrol/Thrush
Armstrong/Aurora
Bell & Gossett
Patterson
Taco
Victaulic
Wheatley

(2) Combination Air/Dirt Separators

A. Manufacturers:

1. Spirotherm, Inc. (model VDT, VHT, VDN or VHN)

2. Approved equivalent – confirm with Engineer prior to bidding

B. Full flow coalescing type combination air eliminator and dirt separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles.

C. Selection shall be based upon system flow with pipe size as a minimum. In no case shall entering velocity exceed 10 feet per second.

D. Unit shall include internal structured elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must be fabricated by the manufacturer and consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.

E. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

F. Units shall include a side tap valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

G. Unit shall be manufactured with a removable lower head for internal inspection.

H. Unit shall be manufactured with internal magnets.

1. Magnet(s) shall be positioned at the centerline of the inlet and outlet nozzles for maximum effectiveness during normal operation.

a. Units sized 2” through 6” shall have one magnet

b. Units with 8” though 12” shall have two magnets

2. Magnet(s) shall be removable from the vessel.

3. Magnet(s) shall be made of high-strength Neodymium alloy.

4. Magnet(s) shall be disengaged for dirt blowdown by means of a spring-loaded pull, without requiring removal of the magnet from the vessel or isolating the unit from the system.

5. Magnet option shall be provided with 360° rotatable blow down valve.

(3) Expansion Tank

The tank shall be constructed in accordance with the ASME Code for unfired pressure vessels and shall be suitable for 125 PSI water working pressure and 340ºF maximum water temperature. The tank shall be a pre-charged, heavy duty butyl rubber diaphragm-type pressure vessel complete with standard tire charging valve. Refer to the plans for mounting orientation. Capacities shall be as scheduled on the drawings.

(4) Factory-Assembled Drops

Contractor has the option to utilize pump drop assemblies in lieu of traditional method consisting of flexible connectors and flanged components. Pump Drops shall consist of orange enamel coated assembly, consisting of a flange for pump connection that shall be rated for a pressure greater than or equal to the piping pressure rating of the system. Refer to specification section 201300 - ,PIPE, PIPE FITTINGS AND PIPE SUPPORT. Standard of Acceptance: Victaulic Series 380/381/385/26.

Suction Vibration Isolation Pump Drop: Factory assembled grooved end vibration pump suction drop for pipe sizes 3” through 12”. Consisting of a suction diffuser with stainless steel basket and diffuser, Vic-300 butterfly valve with offset stem for 360-degree circumferential seating, and pipe spool with thermometer and or pressure ports. Assembly is installation-ready, with flexible couplings to accommodate vibration attenuation and stress relief. Assembly rated for working pressure to 300-psig.

Discharge Vibration Isolation Pump Drop: Factory assembled grooved end vibration pump discharge drop for pipe sizes 3” through 12”. Consisting of tri-service valve assembly, which includes a 779 spring-actuated check valve and Vic-300 butterfly valve with offset stem for 360-degree circumferential seating, and pipe spool with thermometer and pressure ports. Assembly is installation ready, with flexible couplings to accommodate vibration attenuation and stress relief. Assembly rated for working pressure is 300-psig.

(5) Suction Diffusers

Provide at the inlet of each base mounted pump, a suction diffuser as manufactured by Bell and Gossett, Victaulic, Thrush, or approved equivalent. Each suction diffuser shall be equipped with a disposable fine mesh start-up strainer and an adjustable support foot to carry weight of inlet piping. Victaulic Series 731 G, W731G, Bell and Gossett Suction Diffuser, or equal.

(6) Flexible Connections

Provide at the inlet and discharge side of each base mounted pump, at each connection to major equipment requiring vibration isolation and where shown on plans, a flexible connector, Metraflex Metrasphere or Engineer approved equal. Flexible connectors shall be of the flexible neoprene and nylon or EPDM and suitable for 225 PSI working pressure and 230°F temperature. Couplings shall be installed per the manufacturer's recommendations, in close proximity to the source of the vibration.

Alternatively, in lieu of a flexible connector, three (3) Victaulic Style 77 flexible couplings may be used on suction side and discharge side of base mounted pumps (six Victaulic flexible couplings per pump).

(7) Pressure Reducing Valve

Provide at the point of connection of the domestic water line to the hydronic system and where shown on the plans, a pressure reducing valve by Thrush, Bell and Gossett, or Engineer approved equivalent. Such pressure reducing shall be provided with an inlet strainer and shall be set to maintain a pressure of 4 PSI in excess of that at the highest point in the hydronic system. Each pressure reducing valves shall be line sized.

(8) Vacuum Breaker

Provide, where shown on the plans, a vacuum breaker as manufactured by Huffman, Jackson or Engineer approved equivalent.

(9) Manual Air Vents

Provide, where shown on the plans, at each rise in piping and where required a manual air vent.

(10) Automatic Air Vents

Provide automatic air vents where noted on the plans.

(11) Expansion Loops

Expansion loops shall be Metaflex Metra loops or Engineer approved equivalent. Install with pipe guides and anchors as recommended by the manufacturer in all piping runs 75 feet long or greater and also where indicated on the plans.

Alternatively, in water piping systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and as required for the elimination of expansion loops. (In accordance with Victaulic recommendations and as approved by the Engineer). Where expansion loops are required in Victaulic piping systems, use Victaulic flexible couplings on the loop(s).

2. FACTORY START-UP REPORTS

A. Provide factory start-up on site by a factory representative (not a third-party contractor) for all HVAC equipment, including rooftop units. Submit factory start-up reports to the Engineer. The Mechanical Contractor and the Controls Contractor shall have a representative on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action taken shall be submitted to Engineer.

B. At a minimum, the report submitted to the Engineer shall include the following data:

(1) Air Handling Units

a. Verify economizer operation
b. Verify operating per sequence of control
c. Discharge air temperature sensor calibration
d. Discharge static pressure
e. Dirty filter differential pressure switch function
f. Outside air temperature sensors calibration
g. Return air temperature sensor calibration
h. Airflow monitoring station calibration
i. VFD response to pressure sensors or other DDC input
j. Smoke detection shut down
k. Freeze protection sequence
l. Fan bearings lubrication
m. Fan not vibrating
n. Fan motor volts / amps
o. Check drive belt tension
p. Check sheave alignment
q. Coils clean
r. Dampers operating properly
s. Filters clean
t. Fan rotation direction

3. WATER TREATMENT

A. SCOPE

Provide a one-year water treatment program for all water loop systems (heating water, chilled water, processed chilled water). The one-year period shall start from the date of substantial completion. The program shall minimize corrosion, scaling, and prevent biological fouling of the piping system.

B. QUALIFICATIONS

Chemicals, service, and equipment shall be supplied by a single water treatment company for undivided responsibility. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of commercial/industrial water treatment for at least 5 years, whose major business is in the field of industrial water treatment. The water treatment company shall have regional water analysis laboratories, service department, and full-time representatives located within the trading area of the job site or facility.

Water treatment company shall be Bluegrass Kesco, Nalco, American Water Treatment, or approved equal.

C. SERVICE

Provide quarterly field service and Owner consultation. System water or fluid shall be tested for proper chemical parameters, clarity, and biological activity. If needed, provide chemical addition. Provide any laboratory and technical assistance required to achieve a successful program.

D. CHEMICALS

Provide one year's supply of the recommended chemical for scale and corrosion protection of the closed loop recirculating system. If needed, provide separate chemical to control microbiological growth in the system. Formulations shall not contain any ingredients which are harmful to system materials of construction.

E. PHASED PROJECTS

Provide multiple trips, testing, treatment, chemicals, etc. as required to accommodate phased projects. Systems that will be constructed and brought on-line in phases shall be treated at the completion of each phase. Under no circumstance shall any portion of the system operate with untreated heat transfer fluid.

F. EQUIPMENT

(1) Bypass Feeder

Provide one 5-gallon bypass chemical feeder for each system. Neptune DBF-5HP or approved equivalent.

(2) HPS Loop Filter LF-1

Harmsco HUR series fluid filter. Refer to schedule on the drawings for selection. Provide with a total of three sets of filter cartridges.

G. REPORTS

A summary of water or fluid quality and treatment shall be provided in writing to the Owner and Engineer after each quarterly site visit. Results of quarterly biological activity tests shall also be provided to the Owner and Engineer.

H. GENERAL

The heating/cooling systems for this contract are hydronic systems and there are several precautions which must be observed during its installation. The Contractor is advised to read all of the manufacturer's instructions prior to commencing the installation.

I. SYSTEM START-UP

The Contractor shall include as a part of his work a factory system fill and start-up by an authorized Factory Representative of the unit manufacturer.

J. CLEANING AND FLUSHING HYDRONIC PIPING SYSTEMS

(1) During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.

(2) After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil and any and all other material foreign to the water.

(3) Before chemical cleaning and sterilization of the entire system, the building loops shall be flushed and purged until free of dirt, debris, and air. During the chemical cleaning and sterilization process the supply and return run-outs shall be temporarily connected together at each coil location.

(4) After purging of the system the Contractor shall add an approved system cleaning solution at the recommended concentration to the entire system. Circulate the system with cleaner for the time recommended by the chemical manufacturer. After prescribed circulation time, flush the system until cleaner is removed.

(5) After chemical cleaning, the entire system shall be sterilized. Introduce a solution of sodium hypochlorite to achieve a chlorine residual of 25 to 50 ppm. Maintain this chlorine level for 12 to 24 hours. Flush out system until chlorine residual in system equals that of the makeup water.

(6) After the system has been completely cleaned and sterilized as specified herein, the individual coils shall be connected permanently to the supply and return runouts and the system filled for operation under normal closed loop conditions. Within 48 hours of the completion of the sterilization implement a water treatment program to passivate all metal surfaces.

END OF SECTION 230200

SECTION 230300 - CONDENSATE DRAINAGE SYSTEM (FOR COOLING EQUIPMENT)

1. GENERAL

   A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this section of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

   B. The Contractor shall provide a complete condensate drainage system to carry all condensate discharge from all cooling equipment from the building. Condensate system shall be installed in accordance with IMC. Provide condensate overflow switch for all condensate producing equipment.

   C. Pipe installation and fabrication shall be in accordance with the section of these specifications entitled PIPE, PIPE FITTINGS AND PIPE SUPPORT and as hereinafter specified.

   D. All piping shall be installed concealed, unless specifically noted otherwise and shall be installed under slabs or underground only when specifically indicated.

   E. Lines installed in ceiling spaces shall be held at the maximum possible elevation and shall be coordinated with all other trades to avoid conflicts.

   F. Condensate drain lines shall be pitched 1/4 inch per foot and installed with cleanout plugs at each change in direction and/or at thirty (30) foot intervals. Where this minimum pitch cannot be attained, contact Engineers.

   G. Horizontal runs of condensate drain lines shall be supported at six (6) foot intervals maximum, or more frequently where required to prevent sags and low spots.

   H. Lengths of horizontal lines shall be held at a minimum due to potential lint collection.

   I. Provide condensate traps in accordance with the manufacturer’s recommendations.

2. MATERIAL

   A. Refer to Section of these Specifications entitled: PIPE, PIPE FITTINGS AND SUPPORT.

3. INSULATION

   A. Refer to Section of these Specifications entitled: INSULATION - MECHANICAL.

END OF SECTION 230300

SECTION 230500 - COMMON WORK RESULTS FOR HVAC, REFRIGERANT MANAGEMENT

Part 1 GENERAL INFORMATION AND PURPOSE

1.01 UNIVERSITY OF KENTUCKY REFRIGERANT MANAGEMENT PLAN (RMP)

1. The purpose of the University of Kentucky's Refrigerant Management Plan (RMP) is to establish the institutional framework necessary for the University to comply with Title VI of the Clean Air Act (CAA), Stratospheric Ozone Protection. The U.S. Environmental Protection Agency (EPA) developed specific regulations contained in 40 CFR 82, Protection of Stratospheric Ozone, to comply with the CAA. Although there are multiple subparts to regulation 40 CFR 82, the University is subject to 40 CFR 82, Subpart B, Servicing of Motor Vehicle Air Conditioners; 40 CFR 82, Subpart F, Recycling and Emissions Reduction; and 40 CFR 82, Subpart H, Halon Emissions Reduction. These regulations establish requirements for the service, maintenance, repair, and disposal of appliances containing ozone depleting substances (ODS) or non-ODS substances.

2. Appliances that contain ODS or non-ODS substances (refrigerants) throughout the University include air conditioners, refrigerators/freezers, HVAC, chilled water fountains, chillers, motor vehicles, and in the case of halons, fire and explosion protection equipment. The University requires all employees, contractors, or vendors that handle, order, service, maintain, repair, or dispose of refrigerants, refrigerant appliances, or halons to comply with this program.

Part 2 REQUIREMENTS

1. Ensure refrigerants are not knowingly released or disposed of during installation, maintenance, service, repair, disposal, or recovery.

2. Ensure only certified technicians are used for work that is reasonably expected to violate the integrity of the refrigerant circuit.

3. Provide Environmental Management Department, Air Quality Compliance Manager (AQCM), with copies of technician's certifications that conducted installation, maintenance, or removal of appliance.

4. Complete and submit form AQ-FORM-101 to AQCM when installing refrigerant appliances, other than small appliances.

5. Complete and submit form AQ-FORM-201 or AQ-FORM-301 to AQCM when conducting maintenance/service/repair on appliances containing 50 pounds or more of class I, class II, or a blend of class I and class II refrigerant per circuit.

6. Complete and submit form AQ-FORM-401 to AQCM when disposing of appliances with more than 5 pounds of refrigerant per circuit.

Part 3 FORMS

1. AQ-FORM-101, New Refrigerant Appliance (pg. 2-3)

Environmental Management

AQ-FORM-101

FORM

NEW REFRIGERANT APPLIANCE

Provider Information	
Contact Name:	
Contact Position:	
Email:	Phone:
Contractor/Vendor:	
Contractor/Vendor Contact:	
Email:	Phone:
Appliance Location	
County:	
Building Address:	
Building Name: if applicable	
Building Number: if applicable	
Specific Location: (i.e., room #, roof, ground, basement)	
Appliance Characteristics	
Manufacturer:	Mfg. Date:
Model #:	Serial #:
Date Installed:	Refrigerant(s) Name:
Appliance Type: (i.e., split system, chiller, reach-in cooler, heat pump)	

Total Number of Refrigerant Circuits:						
Individual Circuit Identification Name, Number, or Description: (more than 6 circuits, use separate sheet)						
Refrigerant Full Charge per Circuit: Lbs. and Oz.						
Category Code per Circuit: (1) ≤5 lb; (2) >5 & <50 lb; (3) ≥50 lb						
Method Used to Determine Refrigerant Full Charge Code: (1) Manufacturer Data; (2) Calculated; (3) Measured; (4) Midpoint Range						

Is this a revision to the full charge: [Y / N]
If yes, explain how the revision was determined:

Date revision occurred:

Appliance monitored by an Automatic Leak Detection System. [Y / N]
System meets the regulatory definition of an Automatic Leak Detection System: [Y / N]

If Yes,

Date system installed:

[ ] Directly detects refrigerants [ ] Indirectly detects refrigerants

And

[ ] Monitors entire appliance [ ] Monitors a portion of the appliance

Environmental Management

AQ-WI-101

WORK INSTRUCTIONS

NEW REFRIGERANT APPLIANCE

Reference Procedure:
AQ-PROC-100

Purpose:
The purpose of these instructions is to collect and maintain required data from a new appliance (or existing appliance not previously inventoried) contained on form AQ-FORM-101 and either enter or supply the data to be entered in SAP (where available on Lexington campus) or submitted to AQCM for submittal into SPHERA to maintain inventory records.

Scope:
The instructions apply to all University employees, contractors, and vendors that install or maintain refrigerant appliances, other than small appliances. A small appliance is one which contains equal to or less than 5 pounds of refrigerant per circuit.

Responsible Personnel:
Environmental Management – Air Quality Compliance Manager
University, Contractor, and Vendor 40 CFR 82, Subpart F Certified Technicians

Supporting Documents:
AQ-FORM-101

Work Instructions:

1. University staff that enter new appliance information into the SAP tracking system must collect the information on form AQ-FORM-101. Use of the actual form is not required as long as the data is entered in SAP.
2. Departments or buildings that own and operate refrigerant appliances not maintained through PPD, MCPPD, or Athletics must complete form AQ-FORM-101 and submit to the AQCM whenever installing new appliances. The AQCM will enter the information into the SPHERA refrigerant software.
3. Contractors and vendors must complete form AQ-FORM-101 whenever installing new appliances and submit to University staff for entry into SAP. For University property not maintained through SAP, the form must be submitted to the Department or building operator, which must forward the information to the AQCM.
4. The AQCM must run weekly reports from SAP to retrieve new equipment to add into SPHERA.

5. As appliances are added into SAP and SPHERA, an appliance identification number will be assigned and future work or disposal will rely on that identifier to manage the appliance.
6. All records, EPA requests, and reports must be maintained for three years. Additionally, the information collected for a new appliance on AQ-FORM-101, must be kept until three years after appliance is retired.

Part 4 WHERE TO SEND FORMS

UK Environmental Management Dept.
Air Quality Compliance Manager
355 Cooper Dr.
Lexington, KY 40506

END OF SECTION 230500

SECTION 230800 - COMMISSIONING OF HVAC

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 commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Energy supply systems, including central-plant steam supply.
2. Heat generation systems, including hot-water boilers and het recovery chillers.
3. Cooling generation systems, including chilled-water systems and central plant chilled water supply.
4. Distribution systems, including air distribution (heating and cooling) systems, steam distribution systems, heating-water distribution systems, chilled-water distribution systems, exhaust systems, air-handling units.
5. Terminal and packaged units, including unit heaters, fan-coil units, finned-tube radiation, variable air volume units.
6. Vibration and sound systems, including sound attenuation, vibration isolation devices
7. Controls and instrumentation, including BAS, energy monitoring and control system.
8. Systems testing and balancing verification, including heating-water piping systems], chilled-water piping systems, domestic hot-water circulating systems, supply-air systems, return-air systems, exhaust-air systems

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital controls.

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.

E. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Heating-water piping and accessories.
4. Cooling-water piping and accessories.
5. Steam and condensate piping and accessories.
6. Refrigerant piping.
7. Metal ducts and accessories.
8. Fans.
9. Particulate air filtration.
10. Air-handling units.
11. Fan Coil Units.
12. Boilers.
13. Chillers.
14. Pumps.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
2. Minimum three years experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:

    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
    b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.

c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

a. Equipment/instrument identification number.
b. Planned commissioning application or use.
c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

a. Capable of testing and measuring performance within the specified acceptance criteria.
b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

1. Contributors to the development of construction checklists shall include, but are not limited to, the following:

a. HVAC&R systems and equipment installers.
b. TAB technicians.
c. HVAC&R instrumentation and controls installers.

H. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

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 Owner. After deficiencies are resolved, reschedule tests.

J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Commissioning tests.
4. Commissioning test demonstrations.

3.2 TAB COMMISSIONING TESTS

A. TAB Verification:

1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. Scope: HVAC&R air systems and hydronic piping systems.
4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
5. Conditions of the Test:

    a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
    b. Systems operating in full heating mode with minimum outside-air volume.
    c. Systems operating in full cooling mode with minimum outside-air volume.
    d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

6. Acceptance Criteria:

    a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
    b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
    c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

END OF SECTION 230800

SECTION 231100 - REGISTERS, GRILLES, DIFFUSERS AND LOUVERS

1. REGISTERS, GRILLES AND DIFFUSERS

   A. GENERAL

      Alternate R, G & D selections, other than manufacturers and models listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Price, Titus, Metalaire, Carnes, Anemostat, Kruegar, and Tuttle & Bailey. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. If Architect elects not to select color, all colors shall be off-white. Factory color samples shall be submitted with shop drawings.

   B. SELECTION

      Refer to the Selections Scheduled on the Drawings.

2. LOUVERS

   A. GENERAL

      Alternate louver selections, other than manufacturer and model listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Ruskin, Air Balance, Airline, Airstream, Louvers and Dampers and Penn. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect unless scheduled otherwise.

   B. LINTELS

      Provide lintels above all louvers as required. Refer to the lintel schedule in Specification Section 201100.

   C. SELECTION

      Refer to the Selections Scheduled on the Drawings.

END OF SECTION 231100

SECTION 231200 - SHEET METAL AND FLEXIBLE DUCT

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section, and which are hereby made a part of the work specified herein.

B. This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's HVAC Duct Construction Standards, Metal and Flexible, and its subsequent addenda. HVAC duct systems shall be fabricated and installed in accordance with the SMACNA duct construction standards (SMACNA-HVAC and SMACNA-Seismic) including Appendix B of the Seismic Restraint Manual Guidelines for Mechanical Systems. These references and plate numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging, accessories, etc. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

C. Ductwork shall be constructed and installed per the latest edition of the International Mechanical Code.

D. Ductwork shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4" above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic to prohibit dust and dirt from entering the installed ductwork, air handling unit, terminal devices, etc. Provide temporary filters on all return grilles and duct openings if the units are running prior to the building being satisfactorily cleaned. Do not install the ductwork if the building is not "dried-in". If this is required, the open ends of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

Prior to purchase and fabrication of ductwork (shop fabricated or manufactured), the Contractor shall coordinate installations with new and existing conditions. Notify the Engineer if there are any discrepancies for resolution.

E. Provide a SMACNA duct cleanliness level "C" per the latest SMACNA standards. [Refer to LEED / Healthcare Requirements]

F. If separate filter grilles are specified for an HVAC unit the Contractors shall remove any unit mounted filters and blank off the unused filter access opening with sheet metal and seal air tight.

G. Wall Penetrations: Where ducts penetrate interior or exterior walls, the walls shall be sealed air tight. Refer to the sleeving, cutting, patching, and repairing section of the specifications for additional requirements.

H. Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.

I. Prior to purchase/shipment of the ductwork, manufacturer shall provide as part of the submittal process scaled, field coordinated AutoCAD drawings of the complete system to be furnished.

Drawings will indicate all system components including fittings, ductwork and manifolds. Drawings shall be available in an electronic format.

2. LOW PRESSURE DUCTWORK

A. General (Low Pressure)

(1) Double turning vanes shall be installed in all square turns and in any other locations indicated.

(2) Provide a “high efficiency” type take-off with round damper (Flexmaster STOD-B03 or approved equal) for all round duct branches from a rectangular main to a GRD. Refer to the detail on the drawings for all installation requirements.

(3) Cross-break all ducts where any duct section dimension or length is 18" or larger.

(4) Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.

(5) Splitter dampers shall be provided in all rectangular supply air duct tees. Damper blade operator shall extend a minimum two inches thru the insulation.

(6) Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc. Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.

(7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. Duct supports shall not exceed 12 ft intervals. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do not suspend ducts from purlins or other weak structural members where no additional weight may be applied. If in doubt, consult the structural engineer.

(8) Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.

(9) All ductwork connections, fittings, joints, etc., including longitudinal and transverse joints, seams and connections shall be sealed. Seal with medium pressure, smooth-textured, water based duct sealant. Sealant shall be UL 181B-M listed, UL 723 classified, NFPA 90A & 90B compliant, permanently flexible, nonflammable, and rated to 15” wg. Apply per manufacturer's recommendations. Contractors shall ensure no exposed sharp edges or burrs on ductwork.

(10) All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.

(11) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, coils, VAV boxes, fan

sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(12) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.

(13) The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.

(14) All fans and other vibrating equipment shall be suspended by independent vibration isolators.

(15) The interior surface of the ductwork connecting to return/exhaust air grilles shall be painted flat black. The ductwork shall be painted a minimum of 24" starting from the grille.

B. Materials (Low Pressure Single Wall)

(1) Ductwork, plenums and other appurtenances shall be constructed of the following:

a. Steel sheets, zinc coated, Federal Specification 00-S-775, Type I, Class E & ASTM A93-59T with G-90 zinc coating or aluminum alloy sheets 3003, Federal Specification AA-A-359, Temper H-14. Utilize Aluminum in MRI Scan Rooms or NMR Room applications.

b. Any ductwork exposed to view (electrical rooms, elevator machine rooms, etc.) shall be double wall and constructed of galvanized steel. Galvanized metal shall be prepped and clean prior to painting. Coordinate with General Contractor.

(2) Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the latest SMACNA 2” W.G. Standard or the below table, whichever is more stringent. When gauge thickness differs, the heavier gauge shall be selected. The below table shall serve as a minimum:

	ROUND DUCT	RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 12	26	UP TO 12	26
12 TO 18	24	13 TO 30	24
19 TO 28	22	31 TO 54	22
29 TO 36	20	55 TO 84	20
37 TO 52	18	85 AND ABOVE	18

C. Miscellaneous (Low Pressure)

(1) Un-insulated Flexible ductwork (for Return Air and Exhaust Air only)

a. Un-insulated flexible ductwork shall be corrugated aluminum. No sections shall be greater than five feet in length. Ductwork shall be UL rated and in accordance with IMC.

b. Flexible ductwork installed in a return or exhaust or other negative static pressure application shall be rated for installation in negative pressure systems.

c. Provide Titus “FlexRight” or equal flexible duct bracing at each diffuser connection utilizing flexible ductwork.

(2) Insulated Flexible Duct – Steel or Aluminum (Use Only Where Indicated)

a. Flexible duct shall be a factory-fabricated assembly consisting of an all steel or aluminum material. Plastic with spiral wire flexible duct is not permitted.

b. All supply flexible duct shall be insulated with 1 ½ inch blanket of glass wool with an outer moisture barrier. The insulation assembly shall have a flame spread of not more than 25 and a smoke development rate of not over 50.

c. Flexible duct shall be rated for 10 inches W.G. static pressure.

d. A single length of flexible duct shall not exceed 4’0”.

e. The minimum bend radius shall be 1 ½ times the duct diameter. The radius shall be measured to the inside edge of the flexible duct.

f. Total offset in any run of flexible duct shall not exceed 90 degrees.

g. Provide a minimum of one hanger of each run of flexible duct. The hanger must be strapped around the flexible duct and secured to the structure above. Hangers shall not be attached to other mechanical or electrical objects. Hangers may be attached to an approved trapeze. Ceiling grid shall not be used to fabricate a trapeze. Support hangers shall be installed horizontal. Screws shall not be used to penetrate the flexible duct to attach the hanger.

h. Flexible duct shall be secured to the rigid duct and appliance with a nylon adjustable, self-locking, strap and a minimum of three sheet metal screws. The flexible duct shall be sealed airtight at each connection with self-adhesive aluminum tape. Fiber or cloth duct tape is not permitted to seal rigid or flexible duct.

i. All flexible duct shall be pressure tested by a testing and balancing agency to ensure the installation is airtight.

j. Provide Titus “FlexRight” or equal flexible duct bracing at each diffuser connection utilizing flexible ductwork.

(3) Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A; neoprene coated glass fabric; 20 oz. for low pressure ducts secured with snap lock.

(4) Turning Vanes: Duro-Dyne or equivalent fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.

(5) Splitter Damper: Splitter damper shall be constructed of 16-gauge galvanized steel. Provide with operating hardware by Ventfabrics, Inc. to include damper blade bracket, ball joint bracket and operator shaft. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

(6) Access Doors; In Ductwork: Flexmaster TBSM, Air Balance, Vent Products or equal. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length. Door shall be 1” thick double-wall insulated with continuous hinge and cam lock. Provide in ducts where indicated or where required for servicing equipment whether indicated or not. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils (water, electric, steam, etc.) and downstream side of VAV boxes and CAV boxes.

(7) Architectural Access Doors in Ceilings or Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees D Panel, Cesco, Milcor or equal. Panels shall be 24”x24” in size and constructed with 16 gauge galvannealed steel for door and frame. In finished areas, provide with primed steel with 1” border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1” border. Door shall include three (3) screwdriver operated cam latches and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors. For fire rated units, provide manufacturer’s standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.

(8) Security Architectural Access Doors in Walls: Provide where required to access equipment, dampers, valves, filters, etc.Provide Kees SSAP Panel, Cesco, Milcor or equal. Panels shall be 24”x24” in size and constructed with 12-gauge steel for door and frame. In finished areas, provide with primed steel with 1” border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1” border. Door shall include key-operated cylinder dead bolt lock (coordinate cylinders and keys with Owner to match facility standards) and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors and straps. For fire rated units, provide manufacturer’s standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.

(9) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air, Pottorf rectangular volume dampers. Frames shall be 4" x 1 "x 16-gauge galvanized steel. Blades shall be opposed

blade 16-gauge galvanized steel with triple crimped blades on 6” centers. Linkage shall be concealed in jamb. Bearings shall be ½” nylon. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(10) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air, Pottorff round volume dampers. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20-gauge steel, 6" long. Damper blades shall be 20-gauge galvanized steel. Axle shall be 3/8"x6” square plated steel. Bearing shall be 3/8” nylon. Provide with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(11) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3-hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16-gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. All fire dampers shall be dynamic. Static fire dampers are not allowed. Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2-hour rating or Ruskin Type DIBD 23 for a 3-hour rating. *All fire dampers at horizontal assembly penetrations where concrete curbs are provided shall be based on Ruskin DFD35/OW (or Ruskin DFD35/OWSS for laboratory, pharmacy, and central sterile exhaust duct systems as described herein).* Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.

(12) Motor Driven Smoke Dampers – Air Foil Blade: Provide Ruskin SD60 smoke damper where required by the locations of smoke partitions or as shown on the plans, whichever is more stringent. Other acceptable manufacturers are Air Balance or Pottorff. All smoke dampers shall be three inches larger than HVAC duct in each direction. Frame shall be a minimum of 18-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close under HVAC system operating conditions) with pressures of at least the maximum possible of the HVAC system in the closed position, and the system maximum duct air velocity in the open position. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Actuator to be mounted outside of air stream. The pressure drop shall not be greater than .16" wg @ 2500 FPM when tested by an independent laboratory. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

(13) Motor Driven Fire/Smoke Dampers – Air Foil Blade: Fire damper shall be constructed and tested in accordance with UL Safety Standard 555. The damper shall be Ruskin FSD60. Other acceptable manufacturers are Air Balance or Pottorff. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Frame is to be a minimum of 16-gauge galvanized steel, rollformed into a structural hat shape channel. Frame seals shall consist of flexible, compression type stainless steel. The damper and actuator electric shall be rated to an elevated temperature or 250 degrees F or 350 degrees F. In addition, the damper must be factory supplied with actuator and sleeve to comply with the requirements of UL 555S. These dampers shall have been constructed and tested in compliance with U.L. Standard 555 and U.L. Standard 555S, current editions. The pressure drop shall not be greater than .25 in.wg. At 2500 fpm when tested by an independent laboratory. Each damper shall bear an approved U.L. label identifying its classification as a Dynamic Rated Fire Damper (Static Rated dampers are not acceptable), and shall further be classified by U.L. as a Leakage Rated Damper for use in Smoke Control Systems. Each damper shall have a 1-1/2-hour fire protection rating, 212EF U.L. Listed fusible link and a leakage class I. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Provide factory supplied caulked sleeve, 20 gauge on dampers through 84” wide and 18 gauge above 84" wide. Actuator to be mounted outside of air stream. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

(14) Motor Driven Control Dampers – Provide Ruskin Model CD50 air foil damper as shown on the plans. Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, 6 inches wide. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Blade seals shall be equal to Ruskinprene. Leakage Rating shall be Pressure/Class 1.

3. MEDIUM PRESSURE DUCTWORK

A. General (Medium Pressure)

(1) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with high velocity, smooth-textured, water based duct sealant. Sealant shall be UL 181B-M listed, UL 723 classified, NFPA 90A & 90B compliant, permanently flexible, non-flammable, and rated to 15” wg. Apply per manufacturer's recommendations.

(2) Ductwork shall be installed per SMACNA Medium or High-Pressure Manual, whichever is applicable. (Latest Edition shall apply.)

(3) All hanger straps shall be 18 ga. minimum with reinforcement angles installed in strict accordance with SMACNA. Flat oval ducts shall be installed with 2"x2"x1/4" angles on top and bottom ducts 18" wide and larger. Use 1"x1"x3/16" angles on ducts under 18" wide.

(4) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA or the duct manufacturer, and/or as indicated. Test openings shall be placed at the discharge of all air handling units and at the

end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(5) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panels at each fire damper located and sized so as to allow hand reset of each fire damper. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. Where access doors are installed in insulated ductwork, the access door shall be the insulated type.

B. Materials (Medium Pressure Single Wall)

(1) All round, rectangular, and oval medium pressure ductwork for systems above 1.5" W.G. shall be Eastern Sheet Metal, United McGill or Semco or equal with construction as required by the latest SMACNA Standard (Refer to required pressure rating of the duct system as outlined in the Duct Schedule of this spec section).

(2) Any ductwork exposed to view shall be double wall and constructed of galvanized steel. Galvanized metal shall be prepped and clean prior to painting. Coordinate with General Contractor.

Ductwork shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Ductwork shall be constructed of materials of the minimum weights or gauges as required by the latest SMACNA Standard (Refer to required pressure rating of the duct system as outlined in the Duct Schedule of this spec section) or the below table. When gauge thickness differs, the heavier gauge shall be selected. The below table shall serve as a minimum:

	ROUND DUCT (or Equivalent Round Diameter for Oval Ducts)	RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 14	26	UP TO 12	26
15 TO 26	24	13 TO 30	24
27 TO 36	22	31 TO 54	22
37 TO 50	20	55 TO 84	20
52 TO 60	18	85 AND ABOVE	18

(3) All medium pressure duct fittings shall be fabricated by the same manufacturer as the spiral pipe. Contractor or field fabricated fittings shall not be accepted. Duct fittings shall be constructed per the latest SMACNA standard (Refer to required pressure rating of the duct system as outlined in the Duct Schedule of this spec section) with continuous welds. Take-off fittings shall be combination type tees (Eastern Sheet Metal Model "CB" or equal). Straight or angle tees are not acceptable. Fittings shall be constructed of the following minimum gauges:

	ROUND DUCT (or Equivalent Round Diameter for Oval Ducts)	RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 50	20	UP TO 36	20
51 TO 60	18	37 TO 60	18
61 TO 84	16	61 AND ABOVE	16

(4) All single wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange on all ductwork greater than 24 inches in size.

C. Miscellaneous (Medium pressure)

(1) Flexible Connectors: Duro-Dyne, Ventfabrics, U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A or IMC, whichever is more stringent; neoprene coated glass fabric; 30 oz. for medium pressure ducts secured with bolted angles. Provide flexible connectors at inlet and outlet of air handling equipment to accommodate a minimum of three times the operating pressure of the system.

(2) Architectural Access Doors In Ceilings or Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees D Panel, Cesco, Milcor or equal. Panels shall be 24”x24” in size and constructed with 16 gauge galvannealed steel for door and frame. In finished areas, provide with primed steel with 1” border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1” border. Door shall include three (3) screwdriver operated cam latches and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors. For fire rated units, provide manufacturer’s standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.

(3) Security Architectural Access Doors in Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees SSAP Panel, Cesco, Milcor or equal. Panels shall be 24”x24” in size and constructed with 12-gauge steel for door and frame. In finished areas, provide with primed steel with 1” border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1” border. Door shall include key-operated cylinder dead bolt lock (coordinate cylinders and keys with Owner to match facility standards) and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors and straps. For fire rated units, provide manufacturer’s standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.

(4) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3-hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16-gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. All fire dampers shall be dynamic. Static fire dampers are not allowed. Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2-hour rating or Ruskin Type DIBD 23 for a 3-hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. *All fire dampers at horizontal assembly penetrations where concrete curbs are provided shall be based on Ruskin DFD35/OW (or Ruskin DFD35/OWSS for laboratory, pharmacy, and central sterile exhaust duct systems as described herein).* Provide an access door for fire damper reset at all fire damper locations.

(5) Motor Driven Smoke Dampers – Air Foil Blade: Provide Ruskin SD60 smoke damper where required by the locations of smoke partitions or as shown on the plans, whichever is more stringent. Other acceptable manufacturers are Air Balance or Pottorff. Frame shall be a minimum of 18-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close under HVAC system operating conditions) with pressures of at least the maximum possible of the HVAC system in the closed position, and the system maximum duct air velocity in the open position. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Actuator to be mounted outside of air stream. The pressure drop shall not be greater than .16" wg @ 2500 FPM when tested by an independent laboratory. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements.

(6) Motor Driven Fire/Smoke Dampers – Air Foil Blade: Fire damper shall be constructed and tested in accordance with UL Safety Standard 555. The damper shall be Ruskin FSD60. Other acceptable manufacturers are Air Balance or Pottorff. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, on 6" maximum centers. Frame is to be a minimum of 16-gauge galvanized steel, rollformed into a structural hat shape channel. Frame seals shall consist of flexible, compression type stainless steel. The damper and actuator electric shall be rated to an elevated temperature or 250 degrees F or 350 degrees F. In addition, the damper must be factory supplied with actuator and sleeve to comply with the requirements of UL 555S. These dampers shall have been constructed and tested in compliance with U.L. Standard 555 and U.L. Standard 555S, current editions. The pressure drop shall not be greater than .25 in.wg. At 2500 fpm when tested by an independent laboratory. Each damper shall bear an approved U.L. label identifying its classification as a Dynamic Rated Fire Damper (Static Rated dampers are not acceptable), and shall further be classified by U.L. as a Leakage Rated Damper for use in Smoke Control Systems. Each damper shall have a 1-1/2-

hour fire protection rating, 212EF U.L. Listed fusible link and a leakage class I. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Appropriate electric actuators shall be installed by the damper manufacturer. Refer to building fire alarm and controls for exact type. Provide factory supplied caulked sleeve, 20 gauge on dampers through 84" wide and 18 gauge above 84" wide. Actuator to be mounted outside of air stream. Provide factory supplied caulked sleeve, gauge as required to meet manufacturer UL installation requirements

(7) Motor Driven Control Dampers – Provide Ruskin Model CD60 air foil damper as shown on the plans. Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blade shall be airfoil shaped, constructed of a dual skinned galvanized steel, 14-gauge equivalent thickness, 6 inches wide. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type. Blade seals shall be equal to Ruskinprene. Leakage Rating shall be Pressure/Class 1.

(8) Access Doors; In Rectangular Medium Pressure Ductwork: Flexmaster TBSM, Air Balance, Vent Products or equal. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length. Door shall be 1" thick double-wall insulated with continuous hinge and cam lock. Provide in ducts where indicated or where required for servicing equipment whether indicated or not. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position.

(9) Access Doors; In Round or Oval Medium Pressure Ductwork: All access doors in round or oval medium pressure ductwork shall be screw and gasketed type. Screws shall be maximum 4 inches on centers. Access door sizes shall be as follows:

DUCT DIAMETER	OPENING SIZE
3-4 inches	4" x 10"
5-6 inches	6" x 10"
7-24 inches	10" x 16"
26-36 inches	16" x 16"
Over 36 inches	16" x 22"

(10) Pressure Relief Doors: *[Designer edit if required]* Provide a pressure relief vent in the supply air ductwork at each air handling unit. It shall be located between the fan outlet and the first manual or automatic (i.e., fire, fire smoke, or any motorized) damper or closure device. It shall be sized to relieve the duct air pressure below the rated pressure construction of the ductwork and above the working pressure of the fan. The supply air relief door shall be Ruskin PRD18 or equal. Provide a vacuum relief vent in the return and/or outside air ductwork at each air handling unit. It shall be located between the air handling unit casing and the first manual or automatic damper or closure device. It shall be sized to relieve the duct vacuum below the rated construction of the ductwork and above the working negative pressure of the fan. The return air relief door shall be Ruskin NRD18 or equal. Automatic fan shutdown upon damper closure shall not be an acceptable protection for either overpressure or vacuum conditions. All duct pressure relief doors shall be of the automatic resetting type unless otherwise noted.

4. CENTRAL STERILE EXHAUST DUCT

A. All ductwork connected to EF20-SUR-2S (including upstream and downstream of air terminal units or flow control valves) shall be 22-gauge stainless steel duct with liquid tight continuous external weld of all seams and joints. Ductwork shall meet all SMACNA requirements for 6" w.g. pressure class ductwork. Provide dielectric connection between steel and any aluminum ductwork. All ductwork shall be sloped a minimum of 1/8" per foot so as to drain back toward the appliance served. Provide drain plugs at the bottom of each duct riser section.

5. LAB/PHARMACY EXHAUST DUCTWORK

A. *PVC Coated Galvanized Ductwork – All Lab Exhaust Duct Systems (including upstream and downstream of air terminal units or flow control valves) connected to the following exhaust fans: EF-PHM-5N, EF11-LAB-2N, EF22-LAB-0S*.

1. All exhaust ductwork down on the plans shall be 4 mil x 4 mil PVC Coated galvanized duct. Ductwork shall meet all SMACNA requirements for 6" w.g. pressure class ductwork. The duct shall be transported, stored, and installed in accordance with SMACNA Advanced Cleanliness standards. Any scratches or imperfections observed in the PVC coating shall be repaired per the manufacturers recommended procedure or removed from the jobsite. No flexible duct shall be allowed on Exhaust systems.

2. All devices located within the exhaust air stream shall be stainless steel or PVC Coated. This includes sound attenuators, screws, dampers, etc.

6. WATER HEATER AND BOILER FLUE STACKS

A. Location

(1) All flues shall be offset to provide, whether indicated or not, a minimum of 10' horizontal separation to any air intake. This distance shall be a 25' minimum on healthcare facilities.

B. Category II and Category IV Appliances (Positive and Negative Pressure Condensing Appliances)

(1) Metal-Fab Corr/Guard, Heat-Fab Saf-T Vent or other approved equal meeting the specification below:

The vent shall be of the double wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II, III, or IV appliances or as specified by the equipment manufacturer.

Maximum temperature shall not exceed 550°F.

Vent shall be listed for an internal static pressure of 6" w.g. and tested to 15" w.g.

Vent shall be constructed on an inner and outer wall with a 1" annular insulating air space.

The inner wall (vent) shall be constructed of AL29-4C superferritic stainless steel, .015 thickness for 6"-12" diameters and .024 thickness for 14"-24" diameters.

The outer wall (casing) shall be constructed of type 304 stainless steel. .018 thickness for 6”-12” diameters and .024 thickness for 14”-24” diameters.

Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.

Product shall carry the appropriate UL listing mark or label.

6” to 12” diameter vent shall have 1” clearance to combustibles at 550°F. 14” to 24” diameter vent shall have 5” clearance to combustibles at 550°F.

7. FLUE CAPS

A. Provide a flue cap on all flues. It shall be similar to the Breident positive downdraft eliminator style.

8. GENERATOR MUFFLER EXHAUST SYSTEM

A. Manufacturer shall provide factory-built modular universal stack/vent system tested and listed by Underwriters Laboratories Inc. UL Listings shall include:

a. UL 103 Standard for Building Heating Appliance Chimneys which may produce exhaust gas at temperatures not exceeding 1000˚F under continuous operating conditions and 1400˚F under intermittent condition when burning gaseous, solid, or liquid fuels as described in NFPA-211

b. Additional UL 103 Type HT 2100˚F burnout test for Solid Fuel.

c. UL 2561 1400˚F Chimney for appliances which may produce exhaust gas at temperatures not exceeding 1400˚F under continuous operating conditions and 1800˚F under intermittent conditions.

d. Additional UL 103/2561 pressure testing for positive pressure applications up to 90 inches W.C. after 1400°F continuous exposure.

B. CONSTRUCTION

A. The double wall fiber insulated exhaust system shall be constructed of all-stainless steel. The materials and construction of modular sections and accessories shall be as specified by the terms of the product’s UL listing.

B.

a. Type 444 or 316L stainless steel inner liner.

b. 3-¼” minimum thick fiber insulation.

c. Type 304 BA stainless steel outer jacket.

d. The entire exhaust system, including all accessories (connectors, hardware, anchor plate supports, guides, drains, and terminals), shall be stainless steel.

B. Inner flue shall have an overlapping male/female socket that protects the rolled flange with sealant against condensate and high-pressure cleaning. The inner joints shall be secured with vee bands on the inner and overlapping locking band on the outer jacket.

C. Exhaust system shall be designed to compensate for all temperature induced thermal expansion, installed to be gastight, and thus prevent leakage of combustion products into a building.

D. Exhaust system is based upon Jeremias Model DWFL+3. Detailed manufacturer's submittal drawings shall be provided for approval prior to installation of the exhaust system.

C. INSTALLATION

A. Roof and wall penetrations shall be factory insulated and UL listed as not to require air ventilation for safe installation around combustible materials.

B. Entire exhaust system from the appliance outlet to the termination point, including accessories shall be from one manufacturer, except where noted.

D. WARRANTY

A. The factory-built modular exhaust system shall be warranted against functional failure for a limited lifetime warranty.

B. Manufacturer shall provide ASHRAE flue sizing calculations confirming the inner diameter is in complete compliance with appliance manufacturer's installation instructions.

9. DUCT SCHEDULE

A. Supply Ducts:

(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units/VAV boxes

:

a. Pressure Class: Positive 2-inch wg Refer to Low Pressure requirements as outlined in section 2 of this spec.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 24.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

(2) Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 6-inch wg Refer to Medium Pressure requirements as outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

(3) Ducts Connected to Variable-Air Volume Air-Handling Units:

a. Pressure Class: Positive 6-inch wg Refer to medium pressure standards as

outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

B. Return Ducts:

(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units :

a. Pressure Class: Negative 2-inch wg Refer to Low Pressure requirements as outlined in section 2 of this spec.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 24.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

(2) Ducts Connected to Air-Handling Units:

a. Pressure Class: Negative 6-inch wg; Refer to Medium Pressure requirements as outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3

C. Exhaust/Relief Ducts:

(1) Ducts Connected to Exhaust Fans:

a. Pressure Class: Negative 6-inch wg Refer to Medium Pressure requirements as outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 24.

(2) Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or Negative 4-inch wg Refer to Medium Pressure requirements as outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: C
c. SMACNA Leakage Class for Rectangular: 24.

(3) Ducts Connected to Laboratory/Pharmacy/Central Sterile Exhaust Fans:

a. Pressure Class: Negative 10-inch wg Refer to Medium Pressure requirements as outlined in section 3 as well as requirements outlined in the appropriate duct sections of this spec.
b. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
c. SMACNA Leakage Class: 3.

D. Outdoor Air Ducts:

(1) Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or Negative 4-inch wg Refer to Medium Pressure requirements as outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: A.

c. SMACNA Leakage Class for Rectangular: 6.

E. Stairwell Pressurization Air Ducts:

(1) Ducts Connected to Stairwell Pressurization Fans:

a. Pressure Class: Positive or Negative 4-inch wg Refer to Medium Pressure requirements as outlined in section 3 of this spec.
b. Minimum SMACNA Seal Class: A.
c. *SMACNA Leakage Class for Rectangular: 6*.

12. Air Leakage Testing of the Ductwork Systems

A. It is the intent of this section to ensure the ductwork installed has minimal air leakage.

B. Air leakage testing shall be accomplished by an AABC or NEBB certified company. Refer to the Test & Balance specifications.

C. It is the intent to test all ductwork. The duct systems which will require testing are as follows:

(1) All supply air duct systems

(2) All return air duct systems.

(3) All stairwell pressurization duct systems.

(4) The following exhaust air duct systems:

a. Pharmacy exhaust connected to EF10_PHM_5N
b. Laboratory exhaust connected to EF11_LAB_2N
c. Isolation room exhaust connected to EF13_ISO_1S
d. Hot room exhaust connected to EF2_HTE_0S and EF5_HTE_1N

D. Do not insulate the supply air systems prior to testing.

E. The maximum allowable air leakage rate for each system tested must conform to SMACNA required leakage class rating as specified in section 11, DUCT SCHEDULE, of this spec.

F. The entire supply air ductwork system shall be tested with some exceptions. On VAV systems, the medium pressure ductwork upstream of the VAV boxes shall only be tested. Cap the duct at the inlet to the VAV box. On low pressure reheat system, all ductwork upstream of the hot water reheat coil shall be tested. The air volume damper and access door upstream of the reheat coil shall be included in the tested system. (Designer, edit above paragraph as required.)

G. All return and exhaust air sheet metal ductwork associated with the systems shall be tested. Flexible ductwork shall not be tested. Cap the main duct prior to the central equipment fan connection. Also cap the branch ducts which serve the diffusers, after the round branch air volume with sheet metal caps. Seal caps well to damper to avoid air loss at this location. This air loss, from the caps, is included in the noted leakage rate.

H. The noted allowable leakage rate is the total allowable. It shall include leakage associated with the following: (Note to Designer to edit.)

(1) All ductwork as described in above paragraphs.

(2) Access doors

(3) Volume dampers

(4) Relief air doors

(5) Smoke dampers

(6) Fire dampers

(7) Fire smoke dampers

(8) End caps used to seal ducts

I. If any duct system fails a test, the contractor shall reseal the system. It shall then be retested until the duct system meets the leakage allowable at no additional cost to the owner.

J. Carefully select the ductwork construction requirements and the type of duct sealant to be used as required to meet the leakage allowances. The sheet metal duct pressure classification is a minimum only. The contractor shall select the appropriate sheet metal pressure classification, duct sealant class and duct sealant materials to meet the project air leakage allowances.

K. A duct pre-installation conference shall be held prior to the installation of the ductwork. Present should be the owner's representative, engineer, Test & Balance Contractor, General Contractor, Mechanical Contractor, Sheet Metal Contractor, Insulation Contractor and the manufacturer's representative of the duct sealant to be used. At this meeting, the contractor shall advise all of the duct materials and sealant materials to be used to meet the air leakage allowances.

L. Whenever the systems are being leak tested by the Test & Balance Contractor, a representative from the Mechanical Contractor shall be present to assist.

END OF SECTION 231200

SECTION 23 1213 - FACILITY FUEL-OIL PUMPS

1.GENERAL

a.RELATED DOCUMENTS

1)Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

b.SUMMARY

1)Section Includes:

(a)Submersible fuel-oil storage tank pumps.
(b)Triplex fuel-oil pumps.
(c)Fuel-oil maintenance systems.

c.DEFINITIONS

1)Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

2)Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

3)Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

d.ACTION SUBMITTALS

1)Product Data: For each type of product.

(a)Include construction details, material descriptions, and dimensions of individual components and profiles.
(b)Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2)Shop Drawings: For fuel-oil pumps.

(a)Include construction details and dimensions of individual components for fuel-oil pumps.
(b)Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

(c)INFORMATIONAL SUBMITTALS

3)Qualification Data: For qualified professional engineer.

4)Field quality-control reports.

5)Sample Warranty: For special warranty.

e.CLOSEOUT SUBMITTALS

1) Operation and Maintenance Data: For fuel-oil pumps and fuel-oil maintenance systems to include in emergency, operation, and maintenance manuals.

2. PRODUCTS

a. PERFORMANCE REQUIREMENTS

1) Maximum Operating-Pressure Ratings: 3-psig (21-kPa) fuel-oil supply pressure at oil-fired appliances.

2) 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.

3) Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

b. TRIPLEX FUEL-OIL TRANSFER PUMP SETS

1) Description: Comply with HI 3.1-3.5.

(a) Type: Positive-displacement, rotary type.
(b) Impeller: Steel gear with crescent
(c) Housing: Cast-iron foot mounted.
(d) Bearings: Bronze, self-lubricating.
(e) Shaft: Polished steel.
(f) Seals: Mechanical.
(g) Base: Steel.
(h) Pressure Relief: Built in.
(i) Discharge Check Valve: Built in.

2) Drive: Direct close coupled

3) Controls:

(a) Maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F.
(b) Seven-day schedule.
(c) Stage multiple pumps to maintain pressure at a common supply manifold.
(d) Alternate pumps to equalize run time.
(e) Alarm motor failure.
(f) Manual reset dry-run protection.
(g) Stop pumps if fuel level falls below pump suction.
(h) De-energize and sound alarm for pump, locked-rotor condition.
(i) Sound alarm for open circuit and for high and low voltage.
(j) Lights shall indicate normal power on, run, and off conditions.

(k) Provide interface with future automatic control system to control and indicate the following:

i) Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
ii) Operating status.
iii) Alarm off-normal status.

4) Piping Furnished with Pumps: Steel with ferrous fittings and threaded or welded joints.

5) Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.

6) Capacities and Characteristics:

(a) Refer to plans and schedules

~~*c. FUEL MAINTENANCE SYSTEM*~~

~~*1)Description: Factory-fabricated and wired fuel maintenance system for fuel-oil filtration; with enclosure, filter, fuel-oil pump, and controls.*~~

~~*(a) System shall be FMG approved and listed and labeled by an NRTL acceptable to authorities having jurisdiction.*~~
~~*(b) Enclosure: NEMA 250, Type 3R, painted steel containing pumps, filters, accessories, and controls. Hinged door on the front of enclosure.*~~
~~*(c) Pump: Comply with HI 3.1-3.5, steel gear with crescent, positive displacement, direct coupled, rotary type.*~~
~~*(d) Materials: Cast-iron housing; bronze bearings; steel shaft; mechanical seals; and built-in, pressure relief bypass valve.*~~
~~*(e) Piping: Steel with malleable-iron fittings and threaded joints or wrought-steel fittings and welded joints.*~~
~~*(f) Spin-On, Replaceable, Multistage Filters:*~~

~~*i) Stage 1: 100-mesh strainer.*~~
~~*ii) Stage 2: Centrifuge to separate particulates and water from oil.*~~
~~*iii) Stage 3: Coalescing water and particulate filter.*~~
~~*iv) Stage 4: 30-micron particulate removal.*~~
~~*v) Stage 5: 10-micron particulate removal.*~~
~~*vi) Stage 6: Minimum 99.5 percent water removal with see-through bowl and water-sensor probe.*~~
~~*vii) Stage 7: 3-micron particulate removal.*~~

~~*(g) Programmable Logic Controller:*~~

~~*i) Alarm on maximum 15-in. Hg (51-kPa) vacuum at pump suction indicating plugged filter.*~~
~~*ii) Alarm on high water level in filter.*~~
~~*iii) Alarm leak in enclosure.*~~
~~*iv) Touch screen; with minimum 2-line, 20-character, backlit, LCD display.*~~
~~*v) Controller strip heater with thermostat.*~~

~~*(h) Interface with automatic control system is specified in Section 230900 "Instrumentation and Control for HVAC" to control and indicate the following:*~~

~~*i) Start/stop system when required by schedule.*~~
~~*ii) Operating status.*~~
~~*iii) Alarm off-normal status.*~~

~~*2) Capacities and Characteristics:*~~

~~*(a) Refer to plans and schedules*~~

d. MOTORS

1) Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

(a) Enclosure: Totally enclosed, fan cooled
(b) Enclosure Materials: Cast iron

3.EXECUTION

a. EXAMINATION

1) Examine roughing-in for fuel-oil pumps to verify actual locations of pump connections before equipment installation.

2) Proceed with installation only after unsatisfactory conditions have been corrected.

b. EARTHWORK

1) Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

c. PREPARATION

1) Close equipment shutoff valves before turning off fuel oil to premises or piping section.

2) Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

d. FUEL-OIL PUMP INSTALLATION

1) Transfer Pumps:

(a) Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
(b) Set pumps on and anchor to concrete base.
(c) Pump Mounting:

i) Install base-mounted pumps on cast-in-place concrete equipment bases.

ii) Comply with requirements for vibration isolation devices specified in Section 202600 "Vibration Controls for HVAC."

2) Install two-piece, full-port ball valves at suction and discharge of pumps.

3) Install mechanical leak-detector valves at pump discharge.

4) Install Y-pattern strainer on inlet side of simplex fuel-oil pumps.

5) Install check valve on discharge of simplex fuel-oil pumps.

6) Install suction piping with minimum fittings and change of direction.

~~e.FUEL MAINTENANCE SYSTEM INSTALLATION~~

~~1)Install suction line, with foot valve, at one end of storage tank, 1 inch (25 mm) from the bottom of tank.~~

~~2)Install return line at the opposite end of storage tank from suction line.~~

f.LABELING AND IDENTIFYING

1)Install nameplates and signs on each fuel-oil pump. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment."

g.FIELD QUALITY CONTROL

1) Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

2) Perform the following tests and inspections with the assistance of a factory-authorized service representative:

(a) Start fuel-oil transfer pumps to verify for proper operation of pump, and check for leaks.
(b) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3) Fuel-oil pumps will be considered defective if they do not pass tests and inspections.

4) Prepare test and inspection reports.

h.DEMONSTRATION

i) Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-oil pumps and fuel oil maintenance and monitoring systems

END OF SECTION 231213

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Biocide chemical-feed equipment and controls.
   2. HVAC water-treatment chemicals.

1.2 DEFINITIONS

A. 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.

B. TDS: Total dissolved solids.

1.3 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating chilled water , shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TDS: Maintain a maximum value of 10 ppm.
   7. Ammonia: Maintain a maximum value of 20 ppm.
   8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Open hydronic systems, including condenser water, shall have the following water qualities:
   1. pH: Maintain a value within 8.0 to 9.1.
   2. "P" Alkalinity: Maintain a maximum value of 100 ppm.
   3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   5. TDS: Maintain a maximum value of 10 ppm.
   6. Ammonia: Maintain a maximum value of 20 ppm.
   7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm

   8. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

9. Polymer Testable: Maintain a minimum value within 10 to 40.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
1. Inhibitor injection timers.
2. pH controllers.
3. TDS controllers.
4. Biocide feeder timers.
5. Injection pumps.
6. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: Power and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that and components will withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. 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.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping heating, hot-water piping condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 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:

2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Inhibitor Injection Timers:
   1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
   2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
   3. Test switch.
   4. Hand-off-auto switch for chemical pump.
   5. Illuminated legend to indicate feed when pump is activated.
   6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
   7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

B. pH Controller:
   1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
   2. Digital display and touch pad for input.
   3. Sensor probe adaptable to sample stream manifold.
   4. High, low, and normal pH indication.
   5. High or low pH alarm light, trip points field adjustable; with silence switch.
   6. Hand-off-auto switch for acid pump.
   7. Internal adjustable hysteresis or deadband.

C. TDS Controller:
   1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
   2. Digital display and touch pad for input.
   3. Sensor probe adaptable to sample stream manifold.
   4. High, low, and normal conductance indication.
   5. High or low conductance alarm light, trip points field adjustable; with silence switch.
   6. Hand-off-auto switch for solenoid bleed-off valve.
   7. Bleed-off valve activated indication.
   8. Internal adjustable hysteresis or deadband.
   9. Bleed Valves:

a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

D. Biocide Feeder Timer:
1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two different formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

E. Chemical Solution Tanks:
1. The existing solution tanks are to be used on the new cooling tower system..

F. Chemical Solution Injection Pumps:
1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

G. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

H. Injection Assembly:
1. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).

2.3 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Install automatic chemical-feed equipment for condenser water and include the following:
   1. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
      a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
   2. Install TDS controller with sensor and bleed valves.
      a. Bleed valves shall cycle to maintain maximum TDS concentration.
   3. Install pH sensor and controller with injection pumps and solution tanks.
      a. Injector pumps shall operate to maintain required pH.
   4. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
      a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 23 21 13 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 23 05 23 "General-Duty Valves for HVAC Piping."

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
   4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Remove and replace malfunctioning units and retest as specified above.

D. At four -week intervals following Substantial Completion perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

E. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D 1067.
4. Iron: ASTM D 1068.
5. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 232500

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.

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.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other 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. Roof framing and support members relative to duct penetrations.
   2. Size and location of initial access modules for acoustical tile.

1.4 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.

C. UL Standards: Power ventilators shall comply with UL 705.

1.5 COORDINATION

A. Coordinate size and location of structural-steel support members.

Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Aerovent; a division of Twin City Fan Companies, Ltd.
   2. Greenheck Fan Corporation.
   3. Loren Cook Company.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. 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.

F. Accessories:
   1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted outside 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.

G. 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 cant and mounting flange.
   2. Overall Height: 18 inches.

H. MOTORS
   1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   2. 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.
   3. Enclosure Type: Totally enclosed, fan cooled.

I. SOURCE QUALITY CONTROL
   1. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

2.2 PHARMACY & LABORATORY EXHAUST SYSTEMS

A. GENERAL

1.1 References:

A. Performance ratings: Conform to AMCA standard 210, 260 and 300. Fans must be tested in accordance with AMCA 210, 260 and 300 in an AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210), sound performance (AMCA 300), and induced flow fan for high plume dilution blowers (AMCA 260).

B. Fans shall be UL and CUL listed per UL 705 safety standard.

C. Fans shall meet the criteria of NFPA-45.

D. Classification for Spark Resistant Construction shall conform to AMCA 99.

1.2 Acceptable Manufacturers:

A. Basis-of-Design - The plans and specifications for the laboratory fume hood exhaust system are based on systems and equipment manufactured by Strobic Air Corporation.

B. The engineer and owner shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle cost.

C. Only those systems specifically named in this specification or by addendum shall be considered for approval. Other systems submitted after the bid opening will be returned without review.

1.3 Submittals:

A. Submit shop drawings and product data sheets including performance data, fan performance curves, vibration levels, maintenance requirements and sound power levels.

B. Fan manufacturer shall furnish a certificate of guarantee stating that the fan, mixing plenum, outlet nozzle, acoustical silencer nozzle, stack extension if any, and all related accessories specified herein have been pre-tested at the factory and that the curves supplied in 1.3.1 have been de-rated for any and all system effects created by the accessories.

1.4 Warranty:

A. Fan manufacturer shall provide a 7 year parts warranty from time of purchase to include fan, plenum, motor and drive mechanisms including pillow blocks, sheaves, shafts, couplings and belts. This warranty shall be held solely by the fan manufacturer. It is unacceptable to extend the warranty of a provided component supplier (i.e. motors, dampers, actuators). All warranty claims shall be the sole responsibility of the fan manufacturer.

PART 2 - PRODUCTS

2.1 Mixed-flow induced dilution fans:

A. EF-1 - AMCA Certified Fan - Mixed flow induced dilution high plume fan, AMCA Arrangement 4, AMCA 99 Class "C" Spark Resistance, Fan Model Tested and Certified for AMCA 210, 260, and 300.

2.2 Fan Performance:

A. Fan Performance shall be as stated on the schedule. The Static Pressure stated on the schedule shall be at the inlet to the "Fan System" and does not include any losses of equipment provided by the fan manufacturer (i.e.: HRU, Filters, Silencers, etc…). All losses for the equipment provided by the fan manufacturer shall be detailed in the fan manufacturers technical proposal and or submittal.

B. Fan and all drive components shall have a combined bearing life of a minimum of L10 = 150,000 hours.

C. Fan dynamic balance not to exceed 0.5 mil, peak-to-peak for nominal 900RPM, 1200RPM, and 1800RPM fans, or 0.055 in/sec -peak for 1800 RPM, 0.035 in/sec - peak for 1200 RPM, and 0.030 in/sec-peak for 900 RPM fans measured at the blade pass area when operating at fan frequency. Vibration isolation shall be limited to rubber-in-shear pad type isolators unless otherwise specified.

D. Factory test reports detailing vibration levels at the blade pass area shall be provided. Vibration levels shall be reported in both the axial and radial direction. If fan vibration is greater than 0.5 mils peak-to-peak at the blade pass area, fan manufacturer shall be responsible for providing

vibration isolators on each fan and flexible connection at each duct inlet. Manufacturer shall add 0.5" additional static pressure to the fan system to compensate for losses through the flexible connection. Vibration isolators, 2" deflection seismic rated spring, must be installed on each individual fan with a minimum of four per fan. In addition, fan manufacturer shall be responsible for providing a method to repair or replace flexible connection or vibration isolators without shut down of the fan system. This includes any engineering, additional ductwork, and isolation dampers required to perform repairs while the system is still fully operational. Fan manufacturer shall also provide labor to change out or repair flexible connection and vibration isolators for a seven (7) year period from shipment.

E. The Acoustical Silencer Nozzle shall provide the attenuation values as specified in the following schedule. The published insertion loss values shall be obtained from an AMCA 300 test with the silencer installed on the fan specified. Ratings based on separate silencer and fan testing is not acceptable.

F. The fan supplied must meet the system exhaust CFM and the motor BHP shall not be larger than that shown on the fan schedule. The fan manufacturer shall also provide any additional money required for wiring changes or any other changes required for installation of the equipment. These additional charges shall be detailed on the proposal and include in its total value.

G. The static pressure shown on the schedule is based on the static pressure requirements at the inlet to the mixing box. Any system deviating from the basis of design shall include and detail in their proposal additional losses for flexible connectors, fan losses, elbows, mixing box, etc. that are not included in their fan curves. In addition any deviation from the basis of design shall be subject to requirements stated in sections 1.3.2, 2.1.8 and 2.1.23.

2.3 Fan Maintenance:

A. All fan motors shall be direct-drive.

B. Maintenance shall only be required on a minimum of 18 month intervals. This maintenance shall be limited to re-greasing of the motor bearings.

C. Extended motor lube lines of Teflon tubing covered with braided stainless steel shall be provided. Extended lube lines shall be mounted to a bracket located on the fan housing with grease relief fittings on each line.

2.4 Fan Construction:

A. Impellers shall be mounted directly to the motor shaft to provide Arrangement 4 Direct Drive. Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service. Models that are not Arrangement #4 will be rejected.

B. Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with aerodynamically stable operation at any point on the fan curves.

C. Stationary discharge guide vane sections shall be provided to increase fan efficiencies.

D. Fan shall be constructed to AMCA "C" standards per AMCA 99 with a non-ferrous inlet bell provided in order to reduce sparking in the event of a motor bearing failure.

E. Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports.

F. Fans shall be modular construction and capable of being assembled on the roof.

G. Chemical resistant gaskets shall be provided at all companion flanged joints.

H. Fasteners shall be 316 stainless steel.

I. A bolted access door shall be provided for impeller inspection on each fan.

2.5 System Color:

A. Standard finish color to be gray.

2.6 Fan Coating:

A. All steel and aluminum surfaces components within the airstream that are not stainless steel or fiberglass must be surface prepped by phosphorus wash. These components must be coated with a high solids epoxy with low VOC

2.7 Touchup Paint:

A. Touchup Paint Kit

2.8 Nozzle:

A. Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant.

B. Entrainment wind bands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Wind bands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow.

2.9 Silencer:

A. The silencer shall be constructed with an outer shell of fiber reinforced plastic. The inner liner shall be perforated corrosion resistant steel. The silencer shall match the color of the fans. Acoustic media shall be isolated from the air stream by a non fibrous acoustical media.

2.10 Sound:

Fan Outlet Sound Data For Fan Model M33A20N100I4.
Number of Fans Running: 1 - With silencer, at 60Hz

Frequency	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Outlet Sound Power Levels	87	88	93	93	95	92	89	82
Dynamic Insertion Loss for outlet silencer	0	-4	-9	-11	-12	-13	-9	-4
Corrected Outlet Sound Power Levels	87	84	84	82	83	79	80	78

Corrections for 10 ft Distance	-17	-17	-17	-17	-17	-17	-17	-17
Sound Levels (10 ft)	70	67	67	65	66	62	63	61
'A' Scale Corrections	-26	-16	-9	-3	0	1	1	-1
dB'A' Spectrum (10 ft)	44	51	58	62	66	63	64	60

Net Sound Level at 10 ft: 71dB'A' (at 60Hz)

Frequency	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Outlet Sound Power Levels	87	88	93	93	95	92	89	82
Dynamic Insertion Loss for outlet silencer	0	-4	-9	-11	-12	-13	-9	-4
Corrected Outlet Sound Power Levels	87	84	84	82	83	79	80	78

Corrections for 50 ft Distance	-31	-31	-31	-31	-31	-31	-31	-31
Sound Levels (50 ft)	56	53	53	51	52	48	49	47
'A' Scale Corrections	-26	-16	-9	-3	0	1	1	-1
dB'A' Spectrum (50 ft)	30	37	44	48	52	49	50	46

Net Sound Level at 50 ft: 57dB'A' (at 60Hz)

2.11 Motor:

A. Electric motors shall be TEFC Mill & Chemical Duty , include shaft grounding (no explosion proof rating) to prevent shaft currents from prematurely fluting bearings on VFD driven systems, and a 1.15 service factor and an L10 bearing life of 150,000 hours. Premium Efficient motors shall have regreasable bearings with grease relief fittings in every NEMA frame. Fan motors shall be C-Face and Foot Mounted.

2.12 Disconnect Switch:

A. EF-1, EF-1 - A NEMA 4X non-fused disconnect switch shall be provided, mounted and wired to the motor.

PART 3 - ACCESSORIES

3.1 Plenum:

A. Inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirement of the number of fans listed on the schedule. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs. Safety screens shall be supplied over inlet of fan. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors. The primary air inlets shall be located on the bottom or side as noted on construction drawings.

B. Fan and Mixing Box systems supplied by the manufacturer must have a footprint as shown on the drawings / schedule. Exhaust systems with larger footprints shall not be acceptable.

C. Fans and accessories shall have internal drain systems to prevent rain water from entering building duct system.

D. Single fan plenums shall be of continuously welded, heavy gauge steel construction. For single thickness plenums, coatings shall be the same as specified for the fans.

3.2 Plenum Coating:

A. All steel and aluminum surfaces components within the airstream that are not stainless steel or fiberglass must be surface prepped by phosphorus wash. These components must be coated with a high solids epoxy with low VOC

3.3 Vortex Breaker:

A. Vortex breakers shall be provided on all side inlet and multiple fan plenums.

3.4 Isolation Damper:

A. Aluminum Airfoil Opposed Blade Vertically Mounted, Coated (Spec D) - For use with a damper actuator.

3.5 Isolation Actuator:

A. Electric Isolation Actuator - Two position 24v electrical actuator. Fail safe spring close. Mounted directly on isolation damper control rod.

3.6 Bypass Damper:

A. Bypass dampers shall be provided with all mixing plenums for outside air with primary exhaust. Bypass damper(s) shall be sized to bypass the airflow capacity of one fan at the required static pressure of the system. Dampers will be opposed blade low leakage air foil control dampers with extended shaft for connection to an operator. The dampers shall be all aluminum construction unless otherwise specified. An acoustic louver shall be provided at the inlet to the bypass dampers on systems requiring sound attenuation.

3.7 Bypass Actuator:

A. The dampers shall be controlled by a 24v electric proportional control damper actuators shall be electronic direct-coupled type, which require no crank arm and linkage. Actuators must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500? resistor, a 4 to 20 mA control input from an electronic controller or positioner. Actuators shall have Brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position indication.

3.8 Rain Hoods:

A. Rain hoods shall be provided with each damper.

3.9 Roof Curb:

A. A galvanized steel roof curb shall be provided to support the fans/plenums. The curb shall be minimum 14 gauge and canted for rigidity in wind loads. The curb shall include a rigid fiberglass liner and a wood nailer.

3.10 Variable Frequency Drive (VFD):

A. VFD shall be provided by the controls contractor and installed/wired by the electrical contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 23 24 00 "Identification, Tags, Charts, Etc."

3.2 CONNECTIONS

A. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 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. 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.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 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 233423

SECTION 233600 - AIR TERMINAL UNITS

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. Shutoff, single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.

B. Shop Drawings: For air terminal units. 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. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. 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. Ceiling suspension assembly members.
   2. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.5 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 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anemostat Products; a Mestek Company.
   2. Environmental Technologies, Inc.
   3. Johnson Controls.
   4. Phoenix Controls Corporation.
   5. Titus.
   6. Trane; a business of American Standard Companies.
   7. Nailor.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch (0.85-mm) steel, double wall.
   1. Casing Lining: Adhesive attached, 1-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      a. Cover liner with nonporous foil and perforated metal.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket. Provide access panel to access reheat coil inlet surface.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
   2. Damper Position: Normally closed.

E. Hydronic Coils: Hydronic coils for VAV boxes/terminal unit shall be duct-mounted, separate from the VAV box. Refer to section 238216 – Air Coils.

F. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 250200 "Instrumentation and Control for HVAC" and shall have the following features:
   1. Damper Actuator: 24 V, powered closed, spring return open.
   2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
      a. Occupied and unoccupied operating mode.
      b. Remote reset of airflow or temperature set points.
      c. Adjusting and monitoring with portable terminal.
      d. Communication with temperature-control system specified in Section 23 09 00 "Instrumentation and Control for HVAC."
   3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

2.2 VENTURI TRACKING PAIR

A. Manufacturers: Provide product by the following:
   1. Phoenix Controls
   2. Price.

B. Provide CAV and VAV tracking pair with shut off capability and ability to handle pressure sensor and alarm inputs.

C. Valves to be pressure independent with a 24 VAC power input.

D. Provide tracking pair controller per pair to maintain space pressure relationship as required on plans.

E. Provide BACnet interface for each controller to the building FMS.

2.3 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. Steel Cables: Galvanized steel complying with ASTM A 603.

D. 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.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 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 and for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. 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.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Connect ducts to air terminal units according to Section 23 31 13 "Metal Ducts."

C. Make connections to air terminal units with flexible connectors complying with requirements in Section 23 33 00 "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

END OF SECTION 233600

SECTION 235416 - DUPLEX STAINLESS STEEL FIRETUBE CONDENSING BOILERS

PART 1 – GENERAL

1.1 SCOPE

A. The work to be performed includes all new equipment, labor and materials required to furnish and install ultra high efficiency Fulton Vantage Condensing Hydronic Boilers as described in this product guide specification.

1.2 REFERENCES

A. ASME Section IV
B. CAN-13.1-77, Industrial and Commercial Gas Fired Packaged Boilers
C. CSD1, Controls and Safety Devices
D. CSA-CGA/AGA
E. GE GAP
F. NEC, National Electric Code
G. UL-795
H. UL-726
I. AHRI, BTS-2000

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model, weights (shipping, installed and operating), installation and start-up instructions, and furnished accessory information.

B. Shop Drawings: Submit manufacturer's end assembly drawings indicating dimensions, connection locations, and clearance requirements.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for the boiler including ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels, whose products have been in satisfactory use in service for not less than twenty-five (25) years. The manufacturer must be privately owned and located in North American. The boilers must be manufactured in North America and be able to participate in projects that require a level of content for boiler materials. The specifying engineer, contractor and end customer must have the option to visit the factory during the manufacture of the boilers and be able to witness test fire and other relevant procedures.

B. The boiler shall have an ASME Section IV pressure vessel rated for a maximum allowable working pressure of 160 PSIG and a maximum allowable working temperature of 210˚F.

C. The flame safeguard control on the boiler shall provide full linkage-less operation with servo motors to control the supply of fuel and air to the boiler for combustion.

D. The entire boiler system and its installation shall conform to the manufacturer's instructions, applicable codes and associated National Board requirements.

E. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.

1. Standard Items to be included with every boiler:
   i. Low Water cutoff probe
   ii. High and low gas pressure switches
   iii. Combustion air adapter
   iv. Operating and high temperature probes

F. The equipment shall be of the type, design, and size that the manufacturer currently offers for sale and appears in the manufacturer's current catalog.

G. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.

H. The equipment shall be new and fabricated from new materials. The equipment shall be free from defects in materials and workmanship.

I. All units of the same classification shall be identical to the extent necessary to ensure interchangeability of parts, assemblies, accessories, and space parts wherever possible.

J. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified.

1.5 WARRANTY

Standard Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period provided the boiler is installed, controlled, operated and maintained in accordance with the Installation, Operation and Maintenance Manual.

A.1 Warranty Period for the Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to:

i. Flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory.

ii. Thermal shock for the lifetime of the boiler.

A.2 Warranty Period for all other components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material for a period of two (2) years, non-prorated, from the date of shipment from the factory.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. This specification is based on the Vantage Series boilers as manufactured by Fulton Heating Solutions, Inc. Equivalent units and manufacturers must meet all performance criteria, and will be considered upon prior approval.

B. Basis of Design: Fulton Heating Solutions, Inc. Vantage Condensing Hydronic Boiler Models:

Vantage VTG-6000DF (6,000,000 BTU/hr input)

Other acceptable manufacturers include:

Lochinvar

Cleaver-Brooks

C. The boiler manufacturer shall have the capability to construct an engineered system, skid mounted, for the above referenced boilers. This would include but is not limited to mounting any number of boilers in a common system with common piping headers for water supply, water return, fuel supply, and condensate disposal. Electrical panel boxes for the system must be available along with all wiring requirements. Other available components shall include hydronic pumps, air separators, expansion tanks, and various relevant valves and other accessories. The boiler manufacturer shall have the engineering capabilities for all aspects of the mechanical, electrical and control design aspects of the skid mounted system.

D. The boiler manufacturer shall have a factory authorized service training program, where technicians can attend a training class and ultimately be certified to perform start-up, maintenance and basic troubleshooting on the Vantage boiler. The boiler manufacturer shall have a minimum of ten (10) full time service technicians on staff.

2.2 BOILER CONSTRUCTION

A. The boiler shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. The packaged boiler shall be listed and labeled to UL-795 and UL-726 standards for safety.

B. The pressure vessel design and construction shall be in accordance with Section IV of the ASME Code for heating boilers. The boiler shall comply with CSD-1 code requirements.

C. The firetube area of the heat exchanger where the flue gases will condense shall be constructed using duplex alloys of stainless steel. Austenitic stainless steels of the 300 series, such as 316L or 304, have a relatively high coefficient of linear expansion and thus are unacceptable. Ferritic stainless steels of the 400 series, such as 439, have a relatively low ultimate tensile strength and a relatively low pitting resistance equivalent number and thus are unacceptable.

D. The pressure vessel shell and furnace chamber shall be a minimum 3/8” thick steel, SA-53B ERW pipe or SA-516 Grade 70 plate. A dished head attached to the furnace chamber shall be SA-516 Grade 70 plate. Exhaust pipes attached to the furnace chamber shall be minimum 3” diameter Schedule 40 steel.

E. Boilers with heat exchangers using cast aluminum, cast iron or copper finned tube design platforms are unacceptable.

F. The pressure vessel shall be fully insulated with high temperature insulation.

G. The boiler shall be a fire tube design. The furnace location shall be such that all furnace components are within water-backed areas.

H. The dimensions of the boiler shall not be more than (Length x Width x Flange Height):

155 in x 50.5 in x 88.2 in (3937 mm x 1283 mm x 2240 mm)

The manufacturer shall be responsible for confirming that the submitted boiler meets the size, clearance, and installation requirements of the boiler room space, including all code-required service clearances for other equipment installed in this room.

2.3 BOILER DESIGN

A. External convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated boiler input.

B. The boiler shall have its efficiency witnessed and certified by an independent third party, and the efficiency must be listed on the AHRI directory (www.ahridirectory.org) for natural gas operation. The test parameters for efficiency certification shall be the BTS-2000 standard, with 80˚F return water temperature, 180˚F supply water temperature, steady state operation at full input firing capacity.

The certified thermal efficiency for natural gas/oil firing shall not be less than: 94.0% / 95.6%

C. The boiler shall be designed to operate natural gas firing.

D. The boiler shall have no minimum return water temperature when firing on natural gas and shall be capable of operating in condensing mode.

E. The boiler shall have no minimum return water temperature when firing on natural gas or propane.

F. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or primary/secondary piping arrangements are not required to protect the heat exchanger or pressure vessel from thermal shock or other system related considerations. Boilers requiring the use of flow switches or primary/secondary piping arrangements are unacceptable.

G. It shall be acceptable to install any number of boilers with as little as 1” side clearance on either side of the boiler.

H. It shall be acceptable to vent the boiler using sealed combustion (drawing in fresh air from the outdoors) or to draw air from the mechanical room itself.

1. The flue (exhaust) stack must be AL 29-4C or equivalent material UL-1738/C-UL S636 approved for Category IV condensing, positive pressure applications.
2. The air intake piping must be Schedule 40 PVC or equivalent.
3. The boiler shall be capable of operating with an exhaust draft not exceeding -0.04” W.C. and a combined air intake and exhaust venting pressure drop not exceeding +0.35” W.C.

I. Boilers requiring an intake or exhaust muffler for noise sensitive applications are unacceptable.

2.4 CONTROLS

A. The boiler control panel shall be constructed in a UL 508A approved panel shop.

B. The flame safeguard control shall be capable of linkage-less modulation and shall provide the following:

1. The control shall provide a 30-second pre-purge and post-purge time.

2. The control shall maintain a running history of operating hours, number of cycles, and the most recent six control lockouts.
3. The control is connected to a display module, which is capable of retrieving the information listed above.

C. The boiler shall be set up for a maximum 15:1 turndown when firing on natural gas. Any boiler claiming turndown greater than 15:1 must provide references for five (5) installations of similar capacity operating at the claimed turndown for at least (3) complete heating seasons.

D. Airflow shall be controlled by a butterfly valve connected to a precision servo-motor. Fuel flow shall be controlled by a butterfly valve for gas operation.

E. The burner shall be a forced draft flame retention type automatic burner. The burner housing shall be cast aluminum monobloc type construction. The burner mounting flange must support the burner weight on the boiler independent of any support. Burner shall be furnished with a stainless steel flame retention type of combustion head, capable of withstanding temperatures up to 1400F. This combustion head shall incorporate a diffuser and sleeve that is to direct excess air either around the flame or directly through the diffuser vanes. Adjustment to the diffuser insertion shall be made external to the burner and can be made while the burner is in full operation. Burner must have a flame inspection window positioned at the rear center of the burner housing. Flame shall be viewed without removing any covers. Burner shall come complete with a high efficiency, totally enclosed fan cooled motor (TEFC) and a dynamically balanced blower wheel. The blower wheel must be of the energy efficient, self-cleaning, reverse inclined fan blade type. The sound rating of the burner shall not exceed 80 dBa when measured at 3 feet from the burner.

F. The burner gas ignition system for the main gas shall utilize natural gas or as the fuel source. The gas pilot system components shall include spark ignited pilot assembly, 7000 Volt ignition transformer, pilot safety shut off valve, pilot gas pressure regulator and manual gas shutoff cock. The burner oil ignition system shall be by means of a separate 2 x 5000 Volt direct spark ignition system.

G. The burner shall be equipped with a single pole double throw air pressure switch that will not allow burner to start if there is insufficient combustion air, which is checked prior to each ignition attempt. Before the burner can start the airflow switch must be in the open position to prove the switch is not giving a false signal of sufficient combustion air pressure.

H. Boiler safety controls shall include:

1. Operating Temperature Controller for automatic start and stop.
2. High Limit Temperature Controller with manual reset.
3. One Low Water Cutoff Probe in the boiler shell.
4. Air Safety Switch to prevent operation unless sufficient combustion air is assured.
5. Flame detector to prove combustion.

I. All controls are to be burner or panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired

according to UL requirements. Electrical power supplied shall be 208/230/460/3/60. A control circuit transformer shall be factory supplied, wired and mounted.

J. When multiple boilers are to be installed in a common hydronic loop, a Synex ModSync Boiler Sequencing System shall be used. Please refer to the specification for the ModSync for complete details of the parameters and capabilities associated with it.

2.5 MAIN FUEL TRAIN COMPONENTS

A. A factory mounted main gas train shall be supplied. The gas train shall be fully assembled, wired, and installed on the boiler and shall comply with CSD-1 code. Compliance with other codes is available upon request. The maximum pressure rating of the components shall not be less than one psi. The gas train shall consist of at least two manual shutoff valves, one gas pressure regulator, one automatic safety shutoff valve with prove of closure, one flow control valve, one high gas pressure switch, and one low gas pressure switch. The automatic safety shutoff valve and flow control valve may be the same valve. A pilot gas train, when supplied, shall comply with the same code and maximum gas pressure rating as the main gas train.

B. A factory mounted oil pump set shall be mounted to the boiler assembly and shall be directly driven by a motor independent from the combustion air motor. The oil pump must have an integral regulator to adjust the flow of oil to burner nozzles. There shall be three safety shut off valves (main safety, first stage, and second stage). All piping on the burner valve train must be factory installed. Field connections must be NPT. All wiring of oil train valves and switches must be done at the factory. All components factory installed on the boiler that will come into contact with the B100 Biodiesel shall be of the specific material required for this fuel.

C. The boiler shall not require a compressed air supply to fire on #2 fuel oil.

D. Standard CSD-1 fuel trains shall comply with IRI, which has been replaced by GE GAP. Normally open vent valves are no longer required between the safety shut off valves. NFPA 85 compliance shall be available from the factory to comply with local codes or regulations that specifically require a vent valve.

2.6 BOILER FITTINGS & TRIM

A. The boiler shall be supplied with an ASME Section IV safety relief valve. The safety relief valve size shall be in accordance with ASME code requirements.

B. The boiler shall be supplied with a temperature/pressure gauge to be mounted on the water outlet piping of the boiler.

C. A condensate drain connection shall be provided in the exhaust outlet. A Fulton condensate drain kit will be provided to collect and drain the flue gas condensate.

D. The water supply and return connections on the boiler shall be 150# flanged connections. The water connections shall not be designed to support any external structural load from the piping system.

E. The boiler shall come with lifting eyes and fork truck holes accessible for rigging.

F. Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler.

G. A wiring diagram corresponding to the boiler configuration shall be included with each boiler.

H. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.

2.7 EMISSIONS

A. When operating on Natural Gas, the boiler shall have CO emissions less than 50 ppm corrected to 3% O_2 and NO_x emissions less than 30 ppm corrected to 3% O_2, over the entire turndown range.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturers' installation requirements.

B. The installer shall construct a level continuous concrete pad (min. 3 1/2 inches high) for the entire boiler system according to the boiler manufacturer's erecting instructions.

C. Assemble unit sections and parts shipped loose or unassembled for shipment purposes. Follow manufacturer's installation recommendations and instructions.

D. Install electrical control items furnished by manufacturer per wiring diagram provided by manufacturer.

E. Complete water piping installation as required by manufacturer for operation of system.

F. Provide air intake and exhaust piping, size and type as recommended by the manufacturer.

G. Provide boiler manufacturer recommendation manifold pipe and fittings from each boiler to nearest floor drain or as indicated.

3.2 FIELD QUALITY CONTROL

A. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator.

B. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units, deliver to Owner, and obtain receipt.

END OF SECTION 235416

SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at ARI standard conditions and at conditions indicated.
   2. Performance at ARI standard unloading conditions.
   3. Minimum evaporator flow rate.
   4. Refrigerant capacity of chiller.
   5. Oil capacity of chiller.
   6. Fluid capacity of evaporator, condenser.
   7. Characteristics of safety relief valves.
   8. Minimum entering condenser-fluid temperature.
   9. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in increments.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor 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. Structural supports.
   2. Piping roughing-in requirements.

3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 certification program.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE Compliance:
1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. Comply with NFPA 70.

G. Comply with requirements of UL, and include label by a qualified testing agency showing compliance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each oil-lubricated chiller with a full charge of oil.
1. Ship oil factory installed in chiller.

D. Package chiller for export shipping in totally enclosed crate with bagging.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:
a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant and oil charge.
d. Parts and labor.
e. Loss of refrigerant charge for any reason.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS – HEAT RECOVERY CENTRIFUGAL CHILLER

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Carrier Corporation; a United Technologies company.
2. Trane; a division of American Standard.
3. YORK International Corporation.
4. Daikin.

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, heat-reclaim condenser as indicated, controls, interconnecting unit piping and wiring, and indicated accessories.
1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
2. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
1. Where indicated, provide oil-free compressor technology using a permanent magnet synchronous motor, magnetic bearings, integral variable frequency controller, and digital electronic controls.

B. Compressor:
1. Casing: Cast iron, precision ground.
2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

C. Drive: Direct- or gear-drive, open or hermetic design using an electric motor as the driver.
1. Gear Drives: For chillers with gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards.
2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
3. Seals: Seal drive assembly to prevent refrigerant leakage.

D. Compressor Motor:
1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.

3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. For chillers with open drives, provide motor with open-dripproof enclosure.
5. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
6. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
7. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
1. Overspeed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.
1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide interstage economizers.

H. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.
1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 10 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F for each 10 percent in capacity reduction.
4. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.

I. Oil Lubrication System: Consisting of pump, filtration, heater, cooler, factory-wired power connection, and controls.
1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coastdown, and standby conditions including power failure.
2. Manufacturer's standard method to remove refrigerant from oil.
3. Oil filter shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.

2.4 REFRIGERATION

A. Refrigerant:
1. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:
1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. For Chillers Using low pressure refrigerant: Rupture disc constructed of frangible carbon.

3. For Chillers Using high pressure refrigerant: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using high pressure refrigerant: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

F. Purge System:
1. For chillers operating at subatmospheric pressures (using low pressure refrigerant), factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of non-condensables including, but not limited to, water, water vapor, and non-condensable gases.
2. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
4. Construct components of non-corrodible materials.
5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
6. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to ARI 580.
7. Operation independent of chiller per ASHRAE 147.

G. Positive-Pressure System:
1. For chillers operating at subatmospheric pressures (using R-123 refrigerant), factory install an automatic positive-pressure system.
2. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig adjustable up to a pressure that remains within the vessel design pressure limits.
3. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.5 EVAPORATOR

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:
1. Individually replaceable from either end and without damage to tube sheets and other tubes.

2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: 3/4 inch.
5. Minimum Wall Thickness: 0.028 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:
1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged water boxes.
5. Hinged marine water-box covers.
6. Nozzle Pipe Connections: Welded, ASME B16.5, raised-face flange.
7. Thermistor or RTD temperature sensor factory installed in each nozzle.
8. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection:
1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

2.6 CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:
1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper, copper-nickel alloy, stainless steel, or titanium.
4. Nominal OD: 3/4 inch.
5. Minimum Wall Thickness: 0.028 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:
1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged water boxes.
5. Hinged marine water-box covers.
6. Nozzle Pipe Connections: Welded, ASME B16.5, raised-face flange.
7. Thermistor or RTD temperature sensor factory installed in each nozzle.
8. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection:
1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

2.7 HEAT-RECLAIM CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.

B. For heat recovery chiller HRC-5 only.

C. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

D. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

E. Tubes:
1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: .
4. Nominal OD: 3/4 inch.
5. Minimum Wall Thickness: 0.028 inch .
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:
1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes with lifting lugs or eyebolts.
4. Hinged water boxes.
5. Hinged marine water-box covers.

6. Nozzle Pipe Connections: Welded, ASME B16.5, raised-face flange.
7. Thermistor or RTD temperature sensor factory installed in each nozzle.
8. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection:
1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

2.8 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Thickness: 1-1/2 inches.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.9 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch . Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls.
a. 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.
b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch length of flexible metallic conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95at all operating conditions for heat recovery chiller.
1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.

2. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

2.10 MOTOR CONTROLLER

A. Enclosure: Factory installed, unit mounted, NEMA 250, Type 1, with hinged full-front access door.

B. Control Circuit: Obtained from integral control power transformer with a control power transformer of enough capacity to operate connected control devices.

C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2 for heat recovery chiller.
1. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Visual indication of motor and control status, including the following conditions:
   a. Controller on.
   b. Overload trip.
   c. Loss of phase.
   d. Starter fault.

E. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.
1. Externally Operated Disconnect: Nonfused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than A.
2. Control Relays: Time-delay relays.
3. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   a. Selectable, digital display of the following:
      1) Phase Currents, Each Phase: Plus or minus 1 percent.
      2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      4) Three-Phase Real Power: Plus or minus 2 percent.
      5) Three-Phase Reactive Power: Plus or minus 2 percent.
      6) Power Factor: Plus or minus 2 percent.
      7) Frequency: Plus or minus 0.5 percent.
      8) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.
      9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
   b. Mounting: Display and control unit flush or semirecessed in instrument compartment door.
4. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
5. Power Protection: Chiller shall shut down within six cycles of power interruption.

2.11 VARIABLE FREQUENCY CONTROLLER

A. For chillers CH-1, CH-2, and CH-3.

B. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

C. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

D. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key.

E. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

F. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

G. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
   1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
   2. Regulator shall provide full digital control of frequency and voltage.
   3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.

H. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

I. Operating Requirements:
   1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum.
   2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
   3. Capable of driving full load, without de-rating, under the following conditions:
      a. Ambient Temperature: 0 to 50 deg C.
      b. Relative Humidity: Up to 95 percent (non-condensing).
      c. Altitude: 1000 feet.
   4. Minimum Efficiency: 96 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 98 percent with harmonic filter.
   6. Overload Capability: 1.05 times the full-load current for 7 seconds.
   7. Starting Torque: As required by compressor-drive assembly.
   8. Speed Regulation: Plus or minus 1 percent.
   9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
   10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
   11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

J. Internal Adjustability Capabilities:
   1. Minimum Output Frequency: 6 Hz.
   2. Maximum Output Frequency: 60 Hz.
   3. Acceleration: 2 seconds to a minimum of 60 seconds.
   4. Deceleration: 2 seconds to a minimum of 60 seconds.
   5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

K. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

L. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

M. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.
   7. Motor speed (percent).
   8. Fault or alarm status (code).
   9. Input kilowatts.
   10. Input kilowatt-hours.
   11. Output frequency (Hertz).
   12. Elapsed operating time (hours).

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:
   1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

P. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 3 percent.

Q. Cooling: Air, refrigerant, or water cooled.

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.
   1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

2.12 CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 250, Type 1, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

C. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:
   1. Date and time.
   2. Operating or alarm status.
   3. Fault history with not less than last 10 faults displayed.
   4. Set points of controllable parameters.
   5. Trend data.
   6. Operating hours.
   7. Number of chiller starts.
   8. Entering- and leaving-fluid temperatures of evaporator and condenser.
   9. Difference in fluid temperatures of evaporator and condenser.
   10. Fluid flow of evaporator and condenser.
   11. Fluid pressure drop of evaporator and condenser.
   12. Refrigerant pressures in evaporator and condenser.

13. Refrigerant saturation temperature in evaporator and condenser shell.
14. Compressor refrigerant suction and discharge temperature.
15. Oil temperature.
16. Oil discharge pressure.
17. Phase current.
18. Percent of motor rated load amperage.
19. Phase voltage.
20. Demand power (kilowatts).
21. Energy use (kilowatt-hours).
22. For chillers equipped with variable frequency controllers and harmonic filters, include the following:
    a. Output voltage and frequency.
    b. Voltage total harmonic distortion for each phase.
    c. Supply current total demand distortion for each phase.
    d. Inlet vane position.
    e. Controller internal ambient temperature.
23. Purge suction temperature if purge system is provided.
24. Purge elapsed time if purge system is provided.

D. Control Functions:
1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits.
3. Current limit and demand limit.
4. Condenser-fluid temperature.
5. Variable evaporator flow.
6. Heat reclaim (heat recovery chiller only).

E. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator fluid temperature.
3. High or low oil pressure.
4. High oil temperature.
5. High compressor-discharge temperature.
6. Loss of condenser-fluid flow.
7. Loss of evaporator fluid flow.
8. Motor overcurrent.
9. Motor overvoltage.
10. Motor undervoltage.
11. Motor phase reversal.
12. Motor phase failure.
13. Sensor- or detection-circuit fault.
14. Processor communication loss.
15. Motor controller fault.
16. Extended compressor surge.
17. Excessive air-leakage detection for chillers using R-123 refrigerant.

F. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

G. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

H. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

I. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

J. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
   1. Hardwired Points:
      a. Monitoring: On-off status, common trouble alarm electrical power demand (kilowatts) electrical power consumption (kilowatt-hours) power factor.
      b. Control: On-off operation, (see controls sequence).
   2. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

2.13 FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
   1. Provide at least one coat of primer with a total dry film thickness of at least 2 mils.
   2. Provide at least two coats of epoxy finish with a total dry film thickness of at least 4 mils.
   3. Paint surfaces that are to be insulated before applying the insulation.
   4. Color of finish coat to be manufacturer's standard .

B. Provide Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

2.14 ACCESSORIES

A. Flow Switches:
   1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.
   2. Pressure Differential Switches:
      a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
      b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
      c. Set Point: Screw type, field adjustable.
      d. Electrical Connections: Internally mounted screw-type terminal blocks.
      e. Switch Enclosure: NEMA 250,.
      f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

B. Vibration Isolation:
   1. Chiller manufacturer shall furnish vibration isolation for each chiller.
   2. Neoprene Pad:
      a. Two layers of 0.375-inch- thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
      b. Fabricate pads from 40- to 50-durometer neoprene.
      c. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

2.15 CAPACITIES AND CHARACTERISTICS

A. Heat-Reclaim Condenser:
   1. Pressure Rating:
   2. Number of Passes:
   3. Fluid Type:
   4. Design Fluid Flow Rate:

5. Entering-Fluid Temperature:
6. Leaving-Fluid Temperature:
7. Fluid Pressure Drop:
8. Fluid Velocity:
9. Fouling Factor:

2.16 SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

B. Factory performance test chillers, before shipping, according to ARI 550/590.
   1. Test the following conditions:
      a. Design conditions indicated.
      b. Reduction in capacity from design to minimum load in steps of 25 with condenser fluid at design conditions.
      c. Reduction in capacity from design to minimum load in steps of 25 with varying entering condenser-fluid temperature from design to minimum conditions in increments.
      d. At three point(s) of varying part-load performance to be selected by Owner at time of test.
   2. Allow Owner and Architect access to place where chillers are being tested. Notify Architect 14 days in advance of testing.
   3. Include all travel accommodations for one owner representative and one design team representative to travel to the test site and witness the test.
   4. One chiller is to be capacity tested at the factory before any chillers are shipped. If the chiller passes all of the tests, no further factory testing is required. If the chiller does not pass, all of the remaining chillers are to be factory tested and shown to pass at no additional cost to the owner.
   5. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. For chillers using R-123 refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of 45 psig. Vacuum and pressure test for leaks.

E. For chillers located indoors, rate sound power level according to ARI 575.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
   1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: 1/2 inch.
   2. 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.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge chiller with refrigerant and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 23 21 13 "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

D. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

E. Heat-Reclaim Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

F. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend separate vent piping for each chiller to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

G. For chillers equipped with a purge system, extend separate purge vent piping for each chiller to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.

H. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator, condenser, and heat-reclaim condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions.

END OF SECTION 236416

SECTION 237314 - FACTORY BUILT CUSTOM INDOOR AIR HANDLING UNITS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Design, performance criteria, controls, and installation requirements for indoor mounted Custom Air Handling Units.

1.2 REFERENCES

A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings
B. AMCA Publication 99 – Standards Handbook
C. AMCA Standard 203 – Field Performance Measurement of Fan Systems
D. AMCA Standard 210 – Laboratory Methods of Testing Fans for Performance Rating
E. AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans
F. AMCA Standard 500 – Laboratory Methods for Testing of Dampers and Louvers
G. ARI Standard 410 – Forced Circulation Air-Cooling and Air-Heating Coils
H. ANSI/ASHRAE Standard 111 – Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
I. ASHRAE Standard 52.1 – Dust-Spot Procedures for Testing Air-Cleaning Devices
J. ANSI/ASHRAE Standard 52.2 – Method of Testing Air-Cleaning Devices for Removal Efficiency by Particle Size
K. ANSI/ASHRAE 15 – Safety Standard for Refrigeration Systems
L. ANSI/ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality
M. ANSI/ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential
N. ASTM A-653 – Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process
O. ASTM B117 – Standard Practice for Operating Salt Spray Apparatus
P. NEMA MG1 – Motors and Generators
Q. NFPA 70 – National Electric Code
R. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
S. UL 900 – Test Performance of Air Filters
T. UL 1995 – Standard for Heating and Cooling Equipment

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1
B. Submittals shall include the following:
    1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
    2. Cabinet material, metal thickness, finishes, insulation and accessories.
    3. Ladder-type schematic drawing of the power and auxiliary utility field hookup requirements, indicating all items that are furnished by the manufacturer.
    4. Manufacturer's performance of each unit. Selection shall indicate, as a minimum, the following:
        a. Fan curves with system operating conditions indicated.

b. Certified coil performance ratings with system operating conditions.
c. Calculations required for base rail heights to satisfy condensate trapping requirements of cooling coil.
d. Filters with performance characteristics.
e. Rated load amp draw.
f. Approximate unit shipping weight.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALIFICATIONS

A. Manufacturer shall be a company specializing in the design and manufacture of custom air handling equipment and in business for no less than 15 years.
B. Each unit shall bear an ETL label, conforming to UL Standard 1995.
C. Units shall comply with the requirements of UL 1995 and NFPA 90.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the supervision of the owner in accordance with the manufacturers Operation and Maintenance Instructions.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work performed under this section with work performed under the separate installation contract.

1.8 WARRANTY

A. The complete unit shall be covered by a parts only warranty issued by the manufacturer covering the first year of operation. The warranty period shall start on the date of equipment startup or six months after the date of shipment, whichever occurs first.
B. The installing contractor shall provide labor warranty during the unit’s first year of operation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to the specification requirements listed herein, provide custom air handling units as manufactured by:
1. Air Flow Systems, Inc.
2. ClimateCraft
3. Nortek Air Solutions
4. Trane Custom
5. Air Enterprises

2.2 GENERAL

A. Units shall be completely factory assembled and tested with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. The equipment's cooling, heating, humidifying, ventilating, exhausting capacity and performance shall meet or exceed that shown on the schedule. Tags and decals to aid in service or to indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and Maintenance manuals shall be furnished with each unit.

2.3 CABINET CONSTRUCTION

A. Cabinets shall be constructed in a watertight and airtight manner. The manufacturer's cabinet construction shall result in an ASHRAE/ANSI Standard 111 Leakage Class 5 rating, or better, as measured in accordance with AMCA Standard 210. A leakage rate as a percent of airflow shall only be submitted following calculation at specific project conditions. Maximum casing leakage (cfm/100 ft^2 of casing surface area) = CL X $P^{0.65.}$ Published leakage rates at generic conditions shall not be submitted.

B. Casing deflection shall not exceed L/200 (.0005" per inch) at 1.5 times the casing internal operating pressure at design airflow conditions, not to exceed 12" w. g., whichever is less. L is defined as the panel span taken at the panel seam joint.

C. The unit shall be constructed on an 8" welded structural ~~*tubular*~~ steel base. Base tubing shall be cold-formed carbon steel, electric resistance welded. Equipment using a die-formed sheet metal base is not acceptable. Formed intermediate cross members shall be constructed of hot rolled 12-gauge galvanized steel. After fabrication, the base frame shall be thoroughly cleaned and coated with high solids, polyamide epoxy paint system for superior corrosion resistance.

D. Units shipped in multiple sections shall be engineered for ease of field assembly. Gasket supplied with the unit shall be a high-quality weather resistant closed-cell EPDM sponge rubber. Each section shall include a permanent label to aid in proper field assembly. All gasket and necessary assembly hardware shall ship loose with unit. Floors shall be designed to deflect no more than 1/200 of span under operating conditions.

E. Floors

   a. Shall be fabricated of 3/16″ aluminum tread plate. All floor sheets seams shall be continuously welded and welded to the unit base structure with a 2" turned up lip at the perimeter.

   b. Floor seams at shipping splits shall be welded in the field by the installing contractor. The manufacturer shall provide 3/16" aluminum tread plate strips to cover the floor seams. The strip shall be continuously welded on both sides.

   c. Adiabatic humidifier sections shall have floors fabricated of 10-gauge 316 stainless steel. All floor sheets seams shall be continuously welded and welded to the unit base structure with a 2" turned up lip at the perimeter.

   d. Adiabatic humidifier section floor seams at shipping splits shall be welded in the field by the installing contractor. The manufacturer shall provide 10-gauge 316 stainless steel strips to cover the floor seams. The strip shall be continuously welded on both sides.

   e. All accessible sections without a drain pan shall have a 1.25" diameter floor drain piped through the unit base for drainage.

   f. Floors shall be insulated with a two-part polyurethane water impervious foam insulation. A 20-gauge G90 galvanized steel under liner shall be provided.

F. Wall and roof panels

   a. Panels shall be *4" thick* double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal.

   b. Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 5/16" bolts that can be removed and refastened. Panel attachment with screws is not acceptable. All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.

c. For long term durability, exterior panels shall be a minimum 16-gauge G60 galvanized steel *or aluminum* pre-painted with a baked-on polyester-ceramic paint system that passes a 1,000-hour ASTM B-117 salt spray resistance test and 3000-hour ASTM G-23 accelerated weathering test.

d. Interior liners shall be a minimum 20-gauge 304 stainless steel. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

e. Adiabatic humidifier section interior liners shall be a minimum 20-gauge 316 stainless steel.

G. Insulation

a. All wall and roof panels shall be insulated with an injected foam insulation with an R value of 6.6/inch. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel seam. Insulation shall fill the panel without voids. Panels shall have a minimum 20-gauge 304 stainless steel solid interior liner. The composite R-value of the 4" unit casing shall be no less than *R-17*.

H. Access doors shall be provided into all sections of the air-handling unit as indicated in the plan documents. Doors shall be sized as shown on plan drawings, shall be a minimum 3" thick with *R-17* polyurethane foam insulation and shall be double wall construction using the same material type as the corresponding section. Doors shall comply with the requirements of UL 1995 and NFPA 90. The door frame shall be 0.125" extruded 6063-T5 aluminum. Each door shall be mounted with adjustable die cast aluminum hinges. All doors and mounting frames shall incorporate a thermal break design and the doors shall seal to a replaceable extruded EPDM sponge rubber gasket. Doors shall open against static pressure or shall include a pressure relief feature on the door latch.

a. The door latch assembly shall consist of a roller cam compression arm with a chrome plated steel inner handle and glass fiber/nylon composite outer handle. One tool operated lock shall be provided on each fan section access door. All doors shall have a minimum of two latches.

b. A 10"x12" thermal pane viewing window with one wire mesh safety glass pane and one clear pane shall be provided. The frame shall have a no-through-metal thermal break design. Viewing windows shall be on all doors serving a lighted section. Windows on doors exposed to unit mounted UVC light shall use glass that is resistant to UVC transmission.

I. The entire unit, including walls, roof, doors, joints, and seams shall include thermal break construction. This construction shall be supported by tested performance producing no condensation on the exterior surface when the air tunnel temperature is 50°F DB under the following exterior conditions:

i. $(Th - 50) / (Th - Tdp) < 3.4$

b. Th = Ambient dry bulb temperature (°F) external to housing

c. Tdp = Ambient dew point temperature (°F) external to housing

2.4 FAN ASSEMBLIES – GENERAL

A. The fan shall be of the size and type specified in the unit schedule. To assure maximum performance, fans shall be supplied by a manufacturer specializing in fan design and production.

All fan assemblies shall be designed for heavy-duty industrial applications. Fan framing assemblies shall be fabricated from structural steel electrically welded to form a rigid, integral base. Individual fan assemblies shall be independently isolated.

All motors shall be NEMA design B with Class F insulation. Electrical characteristics and horsepower shall be as specified on the project schedule. All motors shall have a minimum service factor of 1.15. Motors shall have ball bearings. Motors shall be premium efficiency ODP type and shall be factory wired to a fan array motor overload panel. The motor shall be located within the unit and mounted on an adjustable heavy steel base. The motor base shall be fastened securely to the structural steel framing of the fan assembly.

All fans shall meet the minimum efficiency and maximum brake horsepower values as scheduled. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed. Manufacturer must ensure maximum fan RPM is below the first critical speed.

B. Each fan shall be provided with a factory installed airflow measuring device. Airflow device to be mounted out of the direct air stream so as not to affect system static pressure or sound performance. Sensor accuracy shall be +/- 3%. Factory installed assembly shall include flow sensors for field connection to a transducer provided by others.

C. The maximum individual fan size shall be 15 hp.

2.5 FAN ASSEMBLIES – DIRECT DRIVE FAN ARRAY

a) Fan Arrays shall be direct-drive, non-overloading SWSI plenum fans designed for industrial duty and suitable for continuous operation.

i) Fans shall be arranged in an array using one or more welded structural steel assemblies and shall be of the size and quantity specified in the unit schedule. Screwed or riveted frames are unacceptable. Fan assemblies shall be attached directly to base structural members.

ii) Fan wheels shall have a minimum of 12 airfoil blades for superior sound characteristics and shall be constructed of aluminum to reduce rotational weight and vibration. Fan blades shall be extruded aluminum for uniformity and improved vibration characteristics.

iii) Each fan and motor assembly shall be independently isolated within the structural assembly using 1-inch deflection spring isolators. Isolators shall be mounted in a three-point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. If hard mounted or rubber in shear is used in place of internal spring isolations, external isolation of the entire air handling unit is required, no exceptions. Isolation system shall be seismic rated to withstand seismic forces in excess of 4G horizontally and vertically to satisfy specified IBC seismic requirements.

iv) A fan inertia base shall be provided or the fan structure shall exceed an equivalence of 2x mass of the total rotating parts of the fan array. Fan and motor assemblies shall be designed such that no natural frequencies exist within the operating RPM range of the fan, eliminating the need for “lockout” frequency settings in the variable speed drive. The purchasing contractor will be responsible for all costs associated with externally isolating any unit that does not include individual fan isolation.

v) All fan arrays shall meet the minimum motor efficiency, maximum brake horsepower and total motor horsepower values scheduled. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed. Manufacturer must ensure maximum fan RPM is below the first critical speed. Fans shall be Class 2 construction.

vi) All fan and motor assemblies shall be dynamically balanced by the manufacturer to a maximum allowable vibration of 0.040 inches per second at design RPM and a maximum 0.080 inches per second overall vibration limit to bring the fan balance in conformance to a BV-5 Grade G1 per ANSI/AMCA 204. In addition, the manufacturer shall insure that no critical frequencies exist in the fan operating range by varying motor speed in 1Hz increments from design RPM to 50% of design RPM.

b) Unloading

i) Fan curves shall be submitted with the system curve indicating the minimum system operating static pressure and the point of fan surge.

c) Motors

i) Electrical characteristics and horsepower shall be as specified on the project schedule.

ii) Motors shall be Premium Efficiency per NEMA MG1 Table 12-12 type, shall have NEMA Class F insulation, shall meet NEMA Standard MD-1 Inverter Duty rating and shall be designed to withstand 1600V peak voltage spikes and rise times ≥0.1 microseconds.

iii) Motors shall have grease lubricated ball bearings designed to deliver a minimum L10 life of 250,000 hours at full load and the maximum operating RPM of the associated fan. Grease zerks and spring-loaded grease relief valves shall be provided in each motor to allow easy bearing lubrication without damaging the seals due to over lubrication. Permanently lubricated bearings are allowed if a spare motor per fan array is provided.

iv) For efficient operation in a direct drive application, motors shall be capable of operating greater than 60HZ to at least the design operating speed of the fan.

v) Motors shall be factory wired to a motor control center for connection to a VFD. The motor control center shall include for each motor circuit a control device providing overload protection, short circuit protection and a manual disconnect means, and all circuits shall be wired to a common main panel terminal block. Each control device shall include an auxiliary output capable of providing remote notification of a motor failure. All motors shall operate at all times and be controlled in unison, maintaining a consistent and uniform airflow pattern over coils, filters and other devices.

vi) Each motor shall be provided with a shaft grounding device to harmlessly bleed potential induced shaft voltages to ground.

d) Warranty

i) All rotating parts shall be warranted by the unit manufacturer for a full five (5) years from date of unit start-up. Parts warranties provided by third parties are not acceptable.

e) Options

i) In the fan section, provide an overhead motor removal system to facilitate motor replacement. One of the two options below is to be provided.

(1) The assembly shall include a manually operated winch, capable of being easily moved to any motor location.

(2) A structural steel I beam for mounting a trolley to assist in fan motor removal. The beam system shall be mounted overhead of the fan and motor. The beam system shall be supported and mounted to the unit's base support system.

ii) Double wall, sound insulated perforated metal, acoustical baffle plates shall be provided on both side of each individual fan to provide acoustical attenuation.

iii) Ruskin BD6 aluminum gravity backdraft dampers shall be provided on the inlet of each fan to prevent recirculation of air in the event of motor failure.

2) Fan Array Controls

A. Fan arrays shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

B. Each fan array in the air handling unit shall be provided with a factory installed airflow measuring instrument. Every fan in the array will have an airflow measuring device that is guaranteed by the unit manufacturer to have no impact on the fan airflow performance and will not increase the fan sound power. The output of the airflow measurement device on each fan shall be wired by the unit manufacturer back to a central processor mounted on the cabinet exterior that will add the flow from each fan to provide a total airflow for the fan array. Using one air flow measuring device and multiplying by the number of fans provided is not acceptable due to lack of accuracy.
The central processor shall be able to detect and report a fan failure. Auxiliary contacts

on the motor starters are not acceptable as fans can fail without tripping overloads. Current sensors wired into the central processors can be utilized.

C. Piezometric volume taps with pressure transducers are acceptable. Transducer accuracy shall be 1% of pressure reading from full scale down to 30% of full scale reading to improve accuracy to less than 0.5% of calculated flow from 100%-30% of flow. The square root linearization and conversion of the pressure signal to flow shall be done at the central processor. Acceptable pressure transducers are: MatrixMonitor™ Fan Sensor, Omega PX656, Greenheck FMS, Setra Model 239.

D. Measure the airflow back flowing through all failed fans in the array. The backflow shall be subtracted from the sum of the operating fans to provide an accurate delivered airflow for the entire fan array. The system measurement accuracy shall be ±5% of measurement throughout the entire operating range of the fan array down to 15% of design flow. Systems with accuracy rated as a percentage of full scale are not acceptable. The system shall adjust for changes in barometric pressure and temperature to maintain accuracy in changing atmospheric conditions and at any altitude. The system shall be able to measure airflow and report it in units of ACFM or SCFM as selected by the user.
The system shall have the capability to communicate to the BMS with discretely wired analog signals or through an RS485 two wire multi drop network using the BACnet protocols. All information available through the local keypad display unit shall be made available through the BANCet interface. At a minimum, there shall be two locally scalable 0 to 10 VDC signals to report airflow and array pressure rise to the BMS. In addition, there shall be three SPDT relay outputs to report on the condition of the fan array. One relay will switch when the control is energized, one will switch in the event of fan failure detection and one will switch if fan surge is detected.

E. In addition to fan failure detection the system shall also be able to detect and report when any fan is in surge. The system shall have self-diagnostic capabilities and be able to report measurement and system errors. Individual and total flow measurements, entering air temperature and fan array pressure rise shall be available at a unit mounted keypad display.

F. Unit manufacturer shall supply and mount for each fan in the air handler a tri-axial accelerometer used to measure fan vibration. The output of each accelerometer shall be processed in real time through a FFT processor to provide frequency domain vibration for each fan. The vibration readings shall be reported in velocity and available for a frequency range that is a minimum of 3 times the operational speed of the fans. The system shall be capable of checking the fan vibration against user selectable vibration limits and reporting when those limits are exceeded. Each fan vibration sensor will be tied back to the airflow monitor where the individual fan vibration levels can be displayed on the local keypad display and the alarms and data can be transmitted to the BMS through the ~~*MODBUS or*~~ BACnet communication link.

G. Each fan array in the air handler shall be equipped with a grease monitoring system to track the intervals between motor bearing greasing. The system shall monitor the motor shaft speed for every fan motor in the array and integrate this data over time to determine the optimum elapsed time between bearing greasing. The system shall maximize the time interval between motor bearing greases while maintain proper lubrication of the bearings to maximize the motor life. The system shall notify the operator when it is time to grease the motor bearings through a locally mounted keypad display. The system will also estimate the number of days remaining until the motor bearings need to be greased. The system shall be capable of reporting the grease life information to the BMS through an RS485 two wire multi drop network using the ~~*MODBUS or*~~ BACnet communication protocol.

H. ~~*If a BACnet communication interface is desired in lieu of using the standard MODBUS protocol,*~~ the BACnet interface shall be capable of the following protocols: BACnet

MS/TP, BACnet/IP, Modbus/TCP. The following BACnet points shall be available for viewing at the BAS system:

1. Supply fan array total airflow, pressure rise, average temperature, density, average speed, and operating hours left until motor bearings require lubrication.
2. Return fan array total airflow, pressure rise, average temperature, density, average speed, and operating hours left until motor bearings require lubrication.
3. Barometric pressure
4. Monitor board temperature
5. Relay 1 status – power
6. Relay 2 status – fan failure
7. Relay 3 status - warning

2.6 FAN ARRAY SPEED CONTROL AND MOTOR PROTECTION

A. Each variable air volume supply and return fan array shall be provided with an individual variable frequency drive as specified under another specification section.

B. For projects where a VFD controls more than one fan motor, the CAHU manufacturer shall provide, mount, and wire a ***single*** fan array power distribution panel. The power distribution panel shall have a NEMA 3R enclosure. It shall have a main disconnect switch on the incoming line voltage side, a combination motor overload / disconnect for each fan motor, and all necessary wire termination blocks and terminal strips. It shall have a 65,000-amp short circuit withstand rating.

2.7 UNIT SOUND POWER

A. Fan sound power levels (dB) for the unit shall not exceed values as specified on the equipment schedule.

B. Unit manufacturer shall provide certified inlet, supply and casing radiated, sound power levels based on the final unit configuration.

2.8 COILS

A. Provide complete coil section(s) with service access door(s) as shown on the plan drawings. Coil connections shall extend through the section casing for ease of installation. Coil connections must be sealed from both the inside and exterior surfaces of the panel with the sleeve of the inner seal covering the pipe within the depth of the panel, all to minimize leakage and condensation. An integral double wall stainless steel air seal which completely seals around the cooling coil casing and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches.

B. Multiple, “stacked” coil arrangements must be constructed so as to allow independent removal of any coil without the removal of another within the coil bank.

C. All coils shall meet or exceed the capacities specified on the mechanical schedule and all water coil performances shall be certified in accordance with the AHRI Forced Circulation Air Heating and Air Cooling Coil certification program which is based on AHRI Standard 410. Face velocities shall not exceed those specified on the mechanical schedule.

D. All blow-through cooling coils shall have removable stainless-steel mist eliminators as manufactured by Mistop regardless of coil face velocity, no exception.

E. All cooling coil and heating coil sections shall include a double sloped drain pan constructed from 304L stainless steel. All corners shall be welded watertight. Coils shall rest on stainless steel supports. The pan shall have a minimum pitch of 2" from high point to the bottom of the drain outlet connection, providing at least a 1/8” per foot slope. The drain pan shall be

insulated with a 2-part sprayed on polyurethane, water impervious foam. Insulation shall be applied to the entire under side of the drain pan and coil section base assembly. If multiple stacked coils are used, intermediate drain pans are required. Intermediate pans shall be insulated and drained with 3/4" copper down-comers to the main pan. All drain pan openings shall be covered with walk-on aluminum grating for safety. Open drain pan openings are not acceptable.

F. Water coils shall be of a staggered tube design with high efficiency die formed corrugated plate-type fins for maximum performance. All coils shall be tested with 400 psig compressed air under clear water. Coils shall be designed to operate at 300 psig internal pressure and up to 250ºF. Tubes shall be 5/8" diameter, seamless *0.035"* wall copper, mechanically expanded into full drawn fin collars for a continuous compression bond over the full finned length for high efficiency performance. Cooling coil and heating casings shall be a minimum 16-gauge stainless steel. Coil casing reinforcements shall be required for fin lengths over 42". Coil fins shall be 0.0075" thick aluminum as a minimum, *spaced no more than 12 fins/inch*. Coils shall be serviceable using 0.25" M.P.T. drain and vent taps on the supply and return headers. Threaded seamless red brass coil connections shall be brazed to copper supply and return headers.

2.9 NEEDLEPOINT BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA

A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Needlepoint Bipolar Ionization system with output as described here within.

B. The Needlepoint Bipolar Ionization system shall be capable of:

1. Effectively eliminating or inactivating microorganisms downstream of the Needlepoint Bipolar Ionization equipment (mold, bacteria, virus, etc.).

2. Controlling gas phase contaminants generated from human occupants, building structure and furnishings.

3. Capable of reducing static space charges.

4. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum deactivation rates for the following pathogens given the allotted time and in a space condition:

   A. SARS-CoV-2 >98% in 60 minutes or less
   B. MRSA >96% in 30 minutes or less
   C. E.coli > 99% in 15 minutes or less
   D. TB > 69% in 60 minutes or less
   E. C.diff >86% in 30 minutes or less

5. Increasing the interior ion levels, both positive and negative, to a minimum of 2,500 ions/cm³ measured 5 feet from the floor.

C. The Needlepoint Bipolar Ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced from a two-sided electrode housing that includes the required count of needlepoint brush clusters. Uni-polar ion devices shall not be acceptable.

1. Air exchange rates may vary through the full operating range of a constant volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.

2. Velocity Profile: The air purification device shall not have maximum velocity profile.

D. Humidity: Needlepoint Bipolar Ionization systems shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

E. Equipment Requirements:

1. Electrode Specifications (Needlepoint Bipolar Ionization):

a. Electrode housing must be a two-sided type with a minimum of 11 needlepoint brush clusters on each side of the bar, allowing free air flow across the electrodes for proper ion distribution into the air flow.

b. Each Needlepoint Bipolar Ionization system shall include the required number of electrodes and power generators sized to the air handling equipment capacity. Unit shall be capable of treating 6,000 CFM (C univ 6.0), 10,000 CFM (C univ10.0), 15,000 CFM (C univ15.0), or 20,000 CFM (C univ20.0). Bipolar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.

c. Unit and Electrodes shall generally be maintenance free, and it shall cycle polarity to enhance the self-cleaning capabilities of the unit with no moving parts involved. Any system requiring moving parts or routine cleaning, will not be allowed.

d. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating. Electrodes shall be made from carbon fiber to prevent oxidation over time.

e. Electrodes shall provide multiple needlepoint brush clusters with a minimum of 190 million ions per cubic centimeter per cluster. Devices with fewer than 22 needlepoint brush clusters (as is built into the C Univ6.0), 44 needlepoint clusters (as is built into the C Univ10.0), 66 needlepoint clusters (as is built into the C Univ15.0), 88 needlepoint clusters (as is built into the C Univ20.0) are not allowed unless multiple devices are used to equal the total number of ions produced per cubic centimeter as provided by the specified C units noted here in this section.

f. Devices with moving parts are not acceptable.

g. Each Device shall accept universal power supply and be capable of being powered by 24VAC, 110 VAC, or 240 VAC

F. Air Handler Mounted Units:

1. Where so indicated on the plans and/or schedules Needlepoint Bipolar Ionization system(s) shall be supplied and installed. The mechanical contractor shall mount the Needlepoint Bipolar Ionization Generator and wire it to the AHU control power (24VAC) as instructed by the Air Purification Manufacturer's instructions or line voltage subject to power available. Each unit shall be designed with an integral illuminated LED and dry contacts to prove ion output is operating properly. The dry contacts shall close to prove the ion generator is working properly and may be daisy chained in series such that only one dry contact per AHU is required to interface to the BAS. Dry contacts proving power has been applied in lieu of the ion output is actually operating, are not acceptable.

G. Ionization Requirements:

1. Needlepoint Bipolar Ionization device(s) shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.

a. The Needlepoint Bipolar Ionization system shall consist of Needlepoint Bipolar Ionization system and power supply. The Needlepoint Bipolar Ionization system shall be installed where indicated on the plans or specified to be installed.

b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced.Imbalanced levels shall not be acceptable.

c. Ionization output from each electrode shall be a minimum of 190 million ions/cc when tested at 1" from each needle point brush. Single needlepoint devices are not allowed.

d. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum deactivation rates for the following pathogens given the allotted time and in a space condition:

A. MRSA - >96% in 30 minutes or less
B. E.coli - > 99% in 15 minutes or less
C. TB - > 69% in 60 minutes or less
D. C. diff - >86% in 30 minutes or less

Manufacturers not providing the equivalent space deactivation rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELEC accredited independent lab confirming deactivation rates and time meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C.

2. Ozone Generation:

a. The operation of the electrodes or Needlepoint Bipolar Ionization units shall conform to UL 867 ECVP 2998 Zero Ozone Emissions from Air Cleaners, first edition – 2016 with respect to ozone generation. There shall be no ozone generation during any operating condition, with or without airflow.

2.10 FILTERS (ALL EXCEPT HEPA)

A. Provide complete filter section(s) with filter racks and service access door(s) as shown on the plan drawings. Holding frames provided for medium efficiency applications will be accessible. Holding frames provided for high efficiency applications will be upstream accessible. Holding

frames shall be constructed from heavy gauge stainless steel and shall be equipped with polyurethane foam gaskets. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 16 gage materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches

Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The holding frame shall be designed to accommodate standard size filters with the application of the appropriate fastener*. All frames shall be connected in a manner that does not provide protrusions into the filter installation/removal path.* The filter rack shall be designed to use standard 24"x24" and 12"x24" filters only. Odd sized filters are not allowed. Holding frame assemblies shall be sized to meet or exceed the face area specified by the mechanical schedule.

B. All filter racks shall be provided with Camfil C78 (or pre-approved equivalent) filter clips. Clip length shall be selected to match the filter being secured by the clip.

C. Gauges

a. A Magnehelic differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter type. The gauge shall be a diaphragm-actuated dial type, 4¾" O.D., with white dial, black figures and graduations and pointer zero adjustment.

D. Medium efficiency pleated filters shall be 2" thick MERV 8 as rated by ASHRAE Standard 52.1 test methods. Filter media shall be of the non-woven cotton fabric type. Filters shall be UL900 Class 2 listed. 100% outside air units shall have 4" thick MERV 8 filters.

E. High efficiency rigid filters shall be 12" deep, high capacity, pleated, totally rigid disposable type. Filters shall consist of micro-fine synthetic media laminated to a non-woven backing, media support grid, contour stabilizers and enclosing frame. The filter media shall have an average efficiency of MERV ~~*11, 13, 14, and 15*~~ ***16*** as rated by ASHRAE 52.1 test methods as shown on the equipment schedule. The enclosing frame shall be constructed of galvanized steel. It shall be constructed and assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The enclosing frame shall be equipped with protective diagonal support members on both the entering air and air leaving sides of the filters. The filters shall be UL900 Class 2 listed.

~~*2.11 HEPA FILTERS*~~

~~*A. Provide complete filter section with filter racks and service access door(s) as shown on the plan drawings. Holding frames shall consist of holding frame section, constructed of stainless steel of all welded construction and reinforcing flanges as an integral part of the holding frame to preclude the possibility of deflection of the sealing flange. Annular based dimples and mounting holes, gasket seals, receptacle guides, and removable swing bolt assemblies shall all be an integral part of the holding frame. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. The design of the frames shall be such that it will accommodate nominal 24"x24" HEPA filters (23⅝" x 23⅝" actual) in either 6" or 12" depth.*~~

~~*B. HEPA filters shall meet or exceed 99.97%, MERV 17 efficiency on 0.3-micron particles when tested with thermally generated D.O.P. in accordance with the latest industry and military standards. The clean static pressure shall be no greater than 1.0" W.G. when operated at rated airflow. The media shall be glass paper. Filters shall be factory constructed and assembled of galvanized steel frames, corrugated aluminum separators and 100% solid resin sealant.*~~

~~C. Gauges~~

~~a. A Magnehelic differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter type. The gauge shall be a diaphragm actuated dial type, 4¾" O.D., with white dial, black figures and graduations and pointer zero adjustment.~~

2.12 CONTROL DAMPERS

A. Mixing box and economizer outdoor air, return air, and exhaust air openings shall have factory mounted aluminum airfoil low-leak dampers. Damper shall be opposed (exhaust air) and parallel (outdoor air and return air) blade type. Damper frame shall be 0.125" thick aluminum hat channel. Damper shall meet the leakage requirements of ASHRAE Std. 90.1 and of the International Energy Conservation Code by leaking less than 3 CFM/sq. ft. at 1" of static pressure, and shall be tested in accordance with AMCA Standard 500-D.

B. The dampers shall be equal to Ruskin CD50.

2.13 AIR BLENDERS

A. Air blenders shall be manufactured by Blender Product, Inc. Series IV.

B. The air blenders shall be installed where shown on the CAHU details to enhance the mixing of outside air with return air to a mixing effectiveness required to eliminate freeze stat trips, minimize sensor error and enhance outdoor air distribution. Additionally, the air mixing device shall provide even airflow across filters, coils and control sensors.

C. The static mixer shall be capable of 70% range mixing effectiveness when mixing 25% outside air with 75% return air at one mixer diameter downstream of mixer.

D. Static air mixers shall be geometrically scaled to ensure consistent performance across full range of sizes offered. Mixers that are not geometrically scaled are not acceptable. Mixers shall be of counter rotational design.

E. Static air mixers shall be welded and mechanically fastened .080" or .125" thick aluminum. Static air mixers shall have bare aluminum finish.

2.14 ADIABATIC HUMIDIFIERS

A. The humidifier section interior liners and floor shall be constructed of solid 316 stainless steel as noted in the casing construction section.

B. All adiabatic humidifier sections shall include double sloped drain pans constructed from 316L stainless steel. All corners shall be welded watertight. Coils shall rest on stainless steel supports. The pan shall have a minimum pitch of 2" from high point to the bottom of the drain outlet connection, providing at least a 1/8" per foot slope. The drain pan shall be insulated with a 2-part sprayed on polyurethane, water impervious foam. Insulation shall be applied to the entire under side of the drain pan and coil section base assembly. All drain pan openings shall be covered with walk-on aluminum grating for safety. Open drain pan openings are not acceptable.

C. See the adiabatic humidifier specification section for the humidifier requirements.

2.15 ELECTRICAL POWER AND CONTROLS

A. Unit operating voltage shall be 460V, 3-phase, 60Hz. All wiring and electrical equipment supplied by the manufacturer shall conform to and be installed in accordance with the requirements of UL1995.

B. Each section provided with a service access door, or as indicated on the plan drawings, shall be equipped with a vapor proof LED service light. All lights shall be completely installed and wired to a single 60-minute timer switch. All switch boxes shall include a GFCI convenience receptacle. Lights and GFCI outlets shall be wired to a separate 115VAC power connection.

C. Provide copper wires, bus bars, and fittings throughout, except internal wire of the control transformer may be aluminum if copper termination is provided. Identify power supply

terminals with permanent markers. The maximum temperature of terminals shall not exceed 167°F (75°C) when the equipment is tested in accordance with its rating.

D. All wiring, 460VAC and 115VAC, shall be run in plated EMT and Liquid Tight conduit.

E. Mount a permanent nameplate on the unit to display the manufacturer, serial number and model number, date of manufacture, horsepower, current rating and voltage.

2.16 UNIT TESTING AND QUALITY CONTROL

A. The fans shall be factory run tested to insure design integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass all quality control checks and be thoroughly cleaned prior to shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. NOTE: Installation of this equipment shall be performed by a contractor yet to be selected. The equipment supplier and/or manufacturer shall provide all equipment, materials, labor, etc. required for installation and maintenance of this equipment, including required warranty work, inspections as noted herein, owner training, etc., to the installing contractor upon award of the installation.

B. Equipment rigging and assembly to be supervised by the manufacturer's representative. Provide for as long a period of time as is necessary to ensure proper assembly or onsite training but no less than 2 full days.

C. Adjust in alignment on concrete foundations, sole plates or other supporting structure. Level, grout, and bolt in place.

D. Coordinate electrical installation with electrical contractor.

E. Coordinate controls with control contractor.

F. Provide all appurtenances required ensuring a fully operational and functional system.

3.2 START-UP

A. Equipment start-up is to be supervised by the unit manufacturer's representative service organization. Physical connections and start-up are provided by the installing contractor. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.

B. Provide complete Operation & Maintenance Manuals with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

3.3 UNIT PRESSURE TESTING

A. The unit cabinet shall be tested in the field *by the test and balance contractor* after installation by the installing contractor to verify its cabinet leakage rating at design both positive and negative operating static pressure(s). Cabinet leakage shall not exceed a Leakage Class rating of 5 as defined by ANSI/ASHRAE Standard 111. Leak testing shall be performed by measuring the airflow pumped into and out of the air-handling unit at the cabinet design operating static pressure. All unit openings shall be sealed, and field testing shall occur after complete unit assembly and after all controls, power, and other final penetrations are made to the unit casing. The air shall then be pumped into and out of the unit until the appropriate operating pressures are achieved. Airflow measurements shall be performed in compliance with AMCA Standard 210. A detailed report, including all data and test methods, shall be

presented to the owner or his representative prior to equipment shipment. The Engineer shall be present during this testing.

END OF SECTION 237314

SECTION 238216 - AIR COILS

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 types of air coils that are not an integral part of air-handling units:
   1. Hot-water.

1.3 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 air coil. Include rated capacity and pressure drop for each air coil.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.4 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. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 WATER COILS

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. Aerofin Corporation.
   2. Trane.
   3. McQuay
   4. York

C. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

D. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

E. Source Quality Control: Factory tested to 300 psig.

F. Tubes: ASTM B 743 copper, minimum 0.035 inch thick.

G. Fins: Aluminum, minimum 0.01 inch thick.

H. Headers: Seamless copper tube with brazed joints, prime coated.

I. Frames: Galvanized-steel channel frame, minimum 0.064 inch thick for slip-in or flanged mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 23 09 00 "Instrumentation and Control for HVAC," and other piping specialties are specified in Section 23 21 13 "Hydronic Piping."

D. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Section 23 09 00 "Instrumentation and Control for HVAC," and other piping specialties are specified in Section 23 22 13 "Steam and Condensate Heating Piping."

END OF SECTION 238216

SECTION 238219 - FAN COIL UNITS

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 fan-coil units and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 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. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

PART 2 - PRODUCTS

2.1 FAN-COIL UNITS

A. Acceptable Manufacturers:

1. Environmental Technologies, Inc.
2. International Environmental Corporation.
3. McQuay International.
4. Trane.
5. YORK International Corporation.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.

E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with [integral stamped] [cast-aluminum] discharge grilles.

2. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

I. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 23 0513 "Common Motor Requirements for HVAC Equipment."

3. Wiring Termination: Connect motor to chassis wiring with plug connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."

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.

3.3 CONNECTIONS

A. 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 fan coil unit piping connections to field-installed piping. Refer to piping schematics and manufacturer’s piping requirements for fittings, specialties, etc.

3. Connect condensate drain to indirect waste.
   a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Section 01 7900 "Demonstration and Training."

END OF SECTION 238219

SECTION 238239 - UNIT HEATERS

1. GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Cabinet unit heaters with centrifugal fans and hot-water coils.

C. DEFINITIONS

1. BAS: Building automation system.
2. CWP: Cold working pressure.
3. PTFE: Polytetrafluoroethylene plastic.
4. TFE: Tetrafluoroethylene plastic.

D. ACTION SUBMITTALS

1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

a. Plans, elevations, sections, and details.
b. Location and size of each field connection.
c. Details of anchorages and attachments to structure and to supported equipment.
d. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
e. Location and arrangement of piping valves and specialties.
f. Location and arrangement of integral controls.
g. Wiring Diagrams: Power, signal, and control wiring.

E. CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

F. MAINTENANCE MATERIAL SUBMITTALS

1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Cabinet Unit Heater Filters: Furnish one spare filter for each filter installed.

G. QUALITY ASSURANCE

1. 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.
2. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2. PRODUCTS

A. UNIT HEATERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Dunham-Bush, Inc.
   b. Indeeco.
   c. International Environmental Corporation.
   d. Markel Products; a division of TPI Corporation.
   e. McQuay International.
   f. QMark Electric Heating; a division of Marley Engineered Products.
   g. Trane.

2. Description: A factory-assembled and -tested unit complying with ARI 440.
3. Cabinet: Steel with factory prime coating, ready for field painting baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

   a. Recessing Flanges: Steel, finished to match cabinet.
   b. Control Access Door: Key operated.
   c. Extended Piping Compartment: 8-inch wide piping end pocket.

4. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 if required by schedule.
5. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
6. Fan and Motor Board: Removable.

   a. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   b. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

7. Control devices and operational sequences are specified on drawings.
8. BAS Interface Requirements:

   a. Interface relay for scheduled operation.
   b. Interface relay to provide indication of fault at central workstation.

c. Interface shall be BAC-net compatible for central BAS workstation and include the following functions:

a. Adjust set points.
b. Cabinet unit heater start, stop, and operating status.
c. Data inquiry, including outdoor-air damper position, supply-air and room-air temperature.
d. Occupied and unoccupied schedules.

9. Electrical Connection: Factory wire motors and controls for a single field connection.

3. EXECUTION

A. EXAMINATION

1. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. INSTALLATION

1. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 07 92 00 "Joint Sealants."
2. Install cabinet unit heaters to comply with NFPA 90A.
3. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
4. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
5. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

C. CONNECTIONS

1. Piping installation requirements are specified in Section 23 21 13 "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
4. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories."
5. Comply with safety requirements in UL 1995.

D. FIELD QUALITY CONTROL

1. Perform the following field tests and inspections and prepare test reports:

a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

b. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

E. ADJUSTING

1. Adjust initial temperature set points.
2. Occupancy Adjustments: When requested within 12 months of 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.

F. DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 238239

SECTION 238413 - HUMIDIFIERS

PART **1** GENERAL

1.1 Section Includes Low Pressure Nozzle and Evaporative Media Humidifier/Cooler

1.2 RELATED SECTIONS

1. Section 200100 - Common Work Results for HVAC.
2. *Section 238414 – Reverse Osmosis System. Note: the adiabatic humidifier and reverse osmosis water system shall be provided by the same manufacturer; no exceptions*.
3. Section 237314 – Custom Air Handling Units

1.3 REFERENCES

1. ANSI/NFPA 70 - National Electrical Code.
2. UL 998 – UL Standard for Safety for Humidifiers.

1.4 SUBMITTALS

1. Submit under provisions of Section 01300.
2. Product Data: Including but not limited to product descriptions, models, dimensions, component sizes, rough-in requirements, service sizes, and finishes. Include rated capacities, operating weights, furnished specialties, and accessories.
    1. Manufacturer's installation instructions.
    2. Operation and maintenance data.
    3. Minimum water quality requirements and water pressure requirements.
3. Shop Drawings: For each type of humidification system specified.
    1. Details of fabrication, installation of humidifiers.
    2. Piping details, plans, elevations, sections, details of components, and nozzle and media.
    3. Detail of humidifiers and adjacent equipment showing support locations, type of support, weight on each support, and required clearances.
    4. Wiring diagrams including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

1.5 QUALITY ASSURANCE

1. Manufacturer:
    1. Products manufactured in an ISO 9001 certified facility.
    2. For each product specified, provide components by single manufacturer throughout.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction, and marked for intended use.
3. Humidifiers: In compliance with UL 998 – UL Standard for Safety for Humidifiers.

1.6 COMMISSIONING

1. Commissioning of system or systems specified herein is required. Provide personnel and equipment to facilitate commissioning process.
2. Documentation and testing of these systems, as well as training of the Owner’s operation and

maintenance personnel, is required in cooperation with the Commissioning Authority.
3. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.

1.7 DELIVERY, STORAGE, AND HANDLING

1. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.
2. Do not store products in location with conditions outside manufacturer's absolute limits.
3. Materials delivered to the site shall be examined for concealed damage or defects in shipping. Defects shall be noted and reported to the Owner’s Representative in writing.

1.8 PROJECT CONDITIONS

1. Coordinate location and installation of humidifiers in ducts and air-handling units in the space it serves with the electrical, mechanical, and plumbing contractors. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.9 WARRANTY

1. Manufacturer’s Standard Warranty: Two year warranty covers defects in materials and workmanship, commences on date of shipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

1. Acceptable Manufacturers
    1. Condair Ltd., Condair AG
    2. Neptronic
    3. Dristeem

2.2 IN-UNIT LOW PRESSURE NOZZLE

1. General:
    1. Pre-engineered system, for air handler/duct application, uses low pressure nozzle technology to directly inject fine mist into the airstream. Separate evaporative media is not allowed.
    2. Humidifier accepts reverse osmosis and de-ionized water (0.5-15µS).
    3. Low pressure nozzles to operate between 43.5 and 101.5 psi (3-7 bar).
    4. Evaporative media to be porous ceramic material designed for post evaporation and mist elimination.
    5. Electronic controller, which monitors the operation of the system, controls output levels and initiates self-cleaning and flush cycles to ensure hygienic operation.
    6. Humidifier powered by 200-240 volts single phase power supply.
    7. Hydraulic system to supply water to the low pressure nozzles with 7 stages of control. 15 or 31 stage control available as an option.
    8. Duct shall contain nozzle grid, connection hoses. Pumps, valves, controls, and other

mechanical components shall be provided in a separate module for installation external to the air stream.
9. Control panel includes Modbus, BACnet IP, and BACnet MSTP Slave interface for integration into building automation system. BACnet IP BTL certified, BACnet MSTP Master and LonWorks, available as options.
10. Central rack for mounting the control panel and hydraulic unit shall be provided.

2. Nozzle Grid:
    1. Pre-assembled nozzle grid sections with color coded nozzle assemblies for easy connection to staging solenoid valves.
    2. 316SS Low pressure nozzles with capacities of: 3.3 lb/hr (1.5 l/hr), 5.5 lb/hr (2.5 l/hr), 6.6 lb/hr (3.0 l/hr), 8.8 lb/hr (4.0 l/hr), or 11 lb/hr (5.0 l/hr)
    3. Nozzles spray angle can be adjusted into (4) positions to prevent condensing on AHU walls.
    4. Threaded nozzle connections. All other connections to be push fit quick connections.
3. Mist Eliminator:
    1. Additional droplet separator required if air velocity exceeds the allowable limit.
    2. DL without additional mist eliminator allows velocities operation up to 590 fpm (3.0 m/s).
    3. DL with additional mist eliminator allows velocities operation up to 787 fpm (4.0 m/s).
4. Management System:
    1. Microprocessor control using a proportional-integral method for interpreting analog signals from a humidistat and or building control systems.
    2. The controller determines which stages should be activated to meet humidification loads.
    3. The controller activates self-maintenance cycles. This includes controlled flushing of the water supply lines, and drain cycles to maintain cleanliness of the water loop.
    4. Control panel complete with on/off switch, auto drain switch, and LCD touch screen for fault, maintenance, and operational indication.
5. Control panel with backlit Touch Screen Display to have the following functionality:
    1. Service indicator and LED power on.
    2. Intuitive touch screen back-lit graphic display.
    3. Display of relative humidity and set point.
    4. Display of operating hours.
    5. Capacity output.
    6. Real-time date and time.
    7. Error history indication.
    8. Limited capacity adjustment.
    9. Inlet flush and line purging.
    10. Adjustable maintenance intervals and alarms.
    11. Remote relay testing.
    12. Modbus standard host protocol.
    13. Terminal block installed for easy field connections.
6. Humidity Control Methods:
    1. Humidistat/thermostat or BMS control.
    2. Accepts standard modulating control signals.
    3. On/Off, 24 VAC safety loop for On/Off control, air proving, and/or high limit.
7. Hydraulic Assembly:
    1. Packaged Hydraulic Assembly: Shall be installed external to airstream and include all components required for circulation water including; optional pump, Hygiene Plus Silver Ion canister, staging valves, sensors, and drainage system.
    2. A maximum of 31 stage control shall be available as an option, 7 stage standard and controlled by up to (5) 24Vdc solenoid valves.
    3. VFD controlled pump.
    4. Water jet pump to allow for draining of the nozzle supply lines.
    5. The hydraulic unit shall include a Hygiene Plus canister to actively dose the supply water with silver ions as a means of bacteria control.

6. Inlet valve, pressure gauge and sensor to ensure correct supply water pressure of 43.5-101.5 psi (3-7 bar).
7. Standard conductivity sensor to monitor supply water conductivity. Control panel to trigger alarm if conductivity increases above allowable limit.

8. Aerosol Breakdown and Hygiene Control:
    1. Management System capable of real-time flushing, purging and cleaning cycles via the Management System control panel. In the event of no call for humidity, humidifier shall drain all water from the nozzle supply lines.
    2. Humidifier Operation: Aerosol-free operation guaranteed under maximum air velocity of 787 fpm (4.0 m/s).
9. Optional Features/Accessories:
    1. VFD controlled booster pump.
    2. 31 Stage step control.
    3. Remote fault indication board.
    4. Leak detection sensor.
    5. H_2O_2 Hydrogen peroxide dosing system.
    6. Silicone free.
    7. Compressed air flushing connections.
    8. On/Off digital duct high limit humidistat.
    9. Air proving switch.

PART 3 EXECUTION

3.1 EXAMINATION

1. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation
3. If preparation is the responsibility of another installer, notify Architect of deviations from manufacturer’s recommended installation tolerances and conditions.
4. Do not proceed with installation until substrates have been properly prepared and deviations are corrected.
5. Commencement of installation constitutes acceptance of conditions.

3.2 INSTALLATION

1. NOTE: Installation of this equipment shall be performed by a contractor yet to be selected. The equipment supplier and/or manufacturer shall provide all equipment, materials, labor, etc. required for installation and maintenance of this equipment, including required warranty work, inspections as noted herein, owner training, etc., to the installing contractor upon award of the installation.
2. Installing contractor shall install components plumb and level, in accordance with approved shop drawings, product installation details and manufacturer’s recommendations.
    1. Install humidifiers and components per manufacturers' instructions.
    2. Seal humidifier duct penetrations with flange.
    3. Install with required clearance for service and maintenance.

3.3 TESTING AND ADJUSTING

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.

2. Test Results: Reported in writing to Architect.
    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, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
    3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 TRAINING

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.
    1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
    2. Review data in maintenance manuals.
    3. Schedule training with Owner, through Architect, with at least seven days advance notice.

3.5 PROTECTION AND CLEANING

1. Protect humidification system components from damage until date of substantial completion.
2. Repair or replace damaged components that cannot be repaired.
3. Remove temporary protective coverings, excess materials.

END OF SECTION 238413

SECTION 238414 - REVERSE OSMOSIS WATER TREATMENT SYSTEM FOR ADIABATIC HUMIDIFIER SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

1. Humidifier reverse osmosis water treatment system as indicated on drawings and as indicated on schedules.

1.2 QUALITY ASSURANCE

1. Certifications, C-UL US Listed.
2. ISO 9001-2008.

1.3 RELATED SECTIONS

1. 200100-Mechanical General Provisions
2. 238413-Humidifiers

1.4 SUBMITTALS

1. Submit product data under provisions of Section 23. Include product description, model, dimensions, connection sizes and precondition requirements. Include rated outputs, operating weights, furnished specialties, and accessories.
2. Submit manufacturer's installation instructions.
3. Submit operation and maintenance data.
4. Submit coordination drawings. Detail fabrication and installation of RO. Include piping details, plans, and adjacent equipment.
5. Submit minimum water quality requirements and water pressure requirements.

1.5 SCHEDULES

1. Refer to information contained in schedule[s] attached to this specification.
2. RO System shall be of type, capacity, and arrangement as listed in schedule[s]. RO system shall be provided by the adiabatic humidifier manufacturer to ensure that the RO system and humidifier are completely compatible. The RO water system shall provide the water type and quality necessary to ensure proper function of the adiabatic humidification system.
3. Include accessories listed in schedule[s] and those accessories required for type of unit.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

1. The reverse osmosis water treatment system is configured to operate on softened and dechlorinated water.
2. Section Includes skid-mounted package including the following components:
    1. Water Softener
    2. Activated Carbon Filter
    3. Five (5) Micron Pre-filter
    4. Reverse Osmosis Unit

5. Storage Tank
6. Distribution Pump
7. Ultraviolet Sterilizer for Bacteria Control.
8. Instrumentation.
9. Interconnected piping, plumbing and connection fittings.

3. Provide a self-contained, skid-mounted, pre-piped and pre-wired component package to produce Reverse Osmosis (RO) water for humidification purposes. Components and configuration shall be as indicated on the drawings attached to this specification. Provide auxiliary (dry) contacts (normally open or normally closed) for signaling the building automation system.
4. Except as otherwise indicated, provide water treatment systems and ancillary equipment with manufacturer's standard materials and components as indicated by published product information, designed and constructed by manufacturer for complete installation. Site to provide power line, water to the unit and drain (not by humidifier manufacturer) and feedlines to secondary systems.
5. Acceptable Manufacturers: Subject to compliance with requirements, provide the product indicated on drawings/specifications or a comparable product by one of the following, which shall be the same as the adiabatic humidifier manufacturer (no exceptions):
    1. Condair Inc. / Condair Ltd.
    2. Condair Group AG
    3. Culligan
    4. Dristeem
    5. Neptronic
6. The pretreatment equipment shall be designed to remove particulates that can affect the operation of the reverse osmosis unit. The pretreatment equipment shall include the following components:
    1. Water Softener and brine tank.
    2. Activated Carbon Filter ML Systems
    3. Five (5) Micron Pre-filter

2.2 REVERSE OSMOSIS WATER TREATMENT PACKAGE

1. General: Provide reverse osmosis water treatment system of size and capacity as indicated on the schedule and delivering this from its holding tank at a pressure of 3 bars. The system uses a membrane separation process in which water molecules can pass through the membrane, while the majority of salts and minerals are retained and thereafter flushed out the drain. System shall be furnished as a package from the humidifier vendor to include combined distribution skid (RO water treatment system), storage tank, additional system hardware, controls, and all associated devices required for a complete and functioning water treatment system.
2. All equipment listed in this specification shall be factory provided by the manufacturer of the RO package (one of the listed manufacturers). The RO system specified herein shall be factory provided as a skid package. The equipment supplier must be able to provide a fully functional system including all water treatment equipment specified, instrumentation and controls, installation, start-up, owner training and the necessary turnover package including Operation and Maintenance manuals and drawings.
3. Units shall be complete, factory assembled, and tested; and of sizes, arrangements, capacities, and performance as scheduled and as specified in the schedules shown. Units stand-alone use for treating water.
4. Units shall be capable and designed for year-round, 24-hours-a-day operation; and requiring only connections of piping, utilities, and remote sensors, and controllers
5. All components exposed to water shall be made of corrosion resistant material
6. RO water storage tank shall include sterile breathing filter and low-water level cutout switch. RO Tank shall come with a 0.2 micron filter to restrict bacteria movement. The RO water storage tank shall be completely black and opaque, allowing no light to pass through and thus restricting bacterial growth due to light. No transparent or semi-transparent (White translucent) or other

tanks will be accepted.

7. Distribution skid and storage tank:
    1. Provide reverse osmosis skid assembly, fully factory built and tested. RO skid shall consist of the following principal components: one or more RO membranes, one or two RO pumps that pump raw water through the RO membrane at a pressure of 116-174 psi (8-12 bar) and into the RO water tank and one RO water transfer pump, which delivers pressurized RO water to the consumer at 3 bars. RO membranes, pumps and storage tanks are installed on a powder coated steel frame with vibration isolators.
    2. All components exposed to water are made of corrosion-resistant material. All hoses are steel-reinforced and drinking water-approved.
    3. Low-pressure cut-off switch: A pressure switch just after the inlet filter protects the RO pump from dry running.
    4. Both the transfer and RO pump are directly mounted on their electric motors. Power is supplied to the 3-phase asynchronous motors via a magnet-operated protective motor switch.
    5. The RO water storage tank shall be completely black and opaque, allowing no light to pass through and thus restricting bacterial growth. No transparent or semi-transparent (white-milky/semi-clear) or other tanks will be accepted
8. Water Softener: The purpose of the water softener is to remove mineral hardness from water. Softening shall be accomplished by an ion exchange process utilizing a high capacity cation exchange resin in the sodium exchange mode. Automatic regeneration shall be accomplished using a salt (brine) solution.
    1. A non-electric water softener (mechanical only) shall be provided as a pre-treatment to extend the life of the RO Membrane.
    2. A dual tank system shall be used to regenerate on-demand, while the other tank acts on standby and immediately switches over during period of regeneration.
    3. The system shall include two tanks. This duplex configuration shall be flexible to operate in alternating or parallel mode depending on installed program disc. In alternating mode, one tank will be on-line during service. In parallel mode, both tanks will be on-line during service. With either mode, during regeneration cycles, one tank shall provide water to service and to the regenerating tank. A water meter shall initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Service flow shall be down-flow and regeneration flow shall be up-flow.
    4. A combination salt storage tank, with cover, and brine well shall be supplied as part of the system. The brine tank shall be large enough to hold salt for at least ten regenerations between refills. The brine tank shall be made of polyethylene or FRP.
    5. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi (1.7 bar). Pressure shall be used to drive all valve functions. No electric hook-up shall be required. Control valve shall incorporate four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. Service cycle shall operate in a down-flow direction. The brine cycle shall flow up-flow, opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice nozzle and self-adjusting backwash flow control. The control valve will prevent the by-pass of hard water to service during the regeneration cycle.
    6. A combination salt storage and brine production tank shall be manufactured of corrosion resistant, plastic. The brine tank shall have a chamber to house the brine valve assembly. The brine float assembly shall allow for adjustable salt settings and shall provide for a shutoff to the brine refill. The brine tank shall include a safety overflow connection to be plumbed to a suitable drain.
    7. Provide interconnecting plumbing and instrumentation.

9. Activated Carbon Filter: The purpose of the activated carbon filter is to remove chlorine, chloramines, tastes, and odors from the water. The media shall be a high capacity black granular carbon with rugged grain structure, high density and large surface area for efficient removal of chlorine/chloramine as well as other taste, odor, and color-causing organics. It shall work effectively over a wide pH range.
    1. The system shall include one tank. This simplex system is designed to operate in an up-flow mode. This configuration allows the unit to run in service without the need for a backwash cycle.
    2. The tanks shall be designed for a maximum working pressure of 125 psi (8.6 bar) and hydrostatically tested at 300 psi (20 bar). Tanks shall be made of polyethylene and reinforced with a fiberglass wrapping. Each tank shall include a 2.5 inch (6.35 cm) threaded top opening. Each tank shall be NSF approved. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of water.
    3. Each system shall include an activated, acid washed carbon. The media shall be between 8 and 16 Mesh in particle size.
10. Control Panel: Mounted on the main pump station frame, includes a manual on/off/auto switch, fault light indicator, service light indicator, and terminal connection for power and control wiring. Display to show required maintenance 48 hours before service is due. Connection glands for power and control wiring. The control unit which consists of a touch display and a PLC mounted in the IP rated electrical cabinet as well as a power board for the control of the high pressure pump and connection terminals for power supply. From the touch screen, the operator can view the status of the RO system, water levels in the tank, production, adjust alarm limits, view hour counters, view logged alarms. The pump station is electrically wired at the factory and the control panel must be tested at the factory prior to release.
11. Controls and Wiring: Factory-installed microprocessor type to control and monitor unit, communicate to central-control processor. The controller shall be connected to the building DDC control system via BACnet IP.
    1. The unit shall have a factory wired and unit mounted central, electrical control panel with a single power supply connection. All internal wiring shall be in accordance with the National Electrical Code. Unit shall have a non-fused main power disconnect and control components required for automatic operation based on signals from the humidity controls. Control panel shall have terminals for remote control devices.
12. Ultraviolet Water Disinfection System: An optional UV light can be provided to disinfect the water as it passes through the system. UV technology ensures a safe supply of water by using a non-intrusive, physical disinfection method. The flow rates of the UV light vary according to different standards. A flow rate of 11.0, 6.0, and 4.0 gallons per minute are recommended by US Public Health, VIQUA Standard, and NSF/EPA, respectively. Voltages vary from 100 - 240 volts, and the frequency varies from 50 to 60 Hertz. Power consumption is 30 Watts. More than 75% UV transmittance is output.
13. Mixed Bed Ion Exchange Resins, CO_2 dosing and Electrical Conductivity (EC) monitoring:
    1. Provide in the scope of work a modular add-on package which allows for the connection of one or two mixed bed ion exchange resin tanks (polishers), alarms for high conductivity, and CO_2 dosing to the RO tank for increasing the conductivity up to 5 µS/cm.
    2. The modular add-on electrical conductivity (EC) panel shall be added on to the existing pump station and frame. The EC add-on panel will be seamlessly connected to the pump skid, via existing embedded software from the main control panel, no additional or external software will be accepted.
    3. The EC add-on panel shall communicate to the primary control panel on the main pump skid via an Ethernet network cable (RJ45, CAT5 or CAT6), no other means of communication will be accepted.
14. The ion exchange resin tanks shall be furnished with the system to "polish" and demineralize the reverse osmosis water even further, producing deionized water. A conductivity of less than 0.1 µS/cm shall be achieved when passing the reverse osmosis water through the mixed bed filter.

The mixed bed resin shall contain anion and cations that will aid in demineralizing the water even further. To raise the conductivity above 5 µS/cm - CO2 shall be added to RO tank - no salts or minerals shall be introduced to the system to raise conductivity.

15. Self-cleaning module/kit of RO Tank (Clean-in-Place)
    1. Provide alongside the direct room system and main pump assembly a complete means of disinfection and cleaning in place module that periodically adds or doses the RO tank with a disinfection fluid.
    2. The modular self-cleaning add-on box shall comprise a self-priming diaphragm pump with direct digital dosing, a power / control box and a bottle of disinfection fluid.
    3. The pumping system shall incorporate pressure monitoring, integrated flow measurement, dosing timer and auto de-aeration. The Clean-in-Place add-on panel will be seamlessly connected to the pump skid, via existing embedded software from the main control panel, no additional or external software will be accepted.
    4. The add-on self-cleaning module panel shall communicate to the primary control panel on the main pump skid via an Ethernet network cable (RJ45, CAT5 or CAT6), no other means of communication will be accepted.
16. Transfer (Forwarding) Pump
    1. A forwarding pump shall be included with the system whereby the pump can transfer RO water to other uses outside of the intended primary humidification equipment.
    2. Forwarding pump shall be embedded onto the main pumping station and installed at the factory by the RO water treatment manufacturer.

PART 3 - EXCECUTION

3.1 Installation

1. NOTE: Installation of this equipment shall be performed by a contractor yet to be selected. The equipment supplier and/or manufacturer shall provide all equipment, materials, labor, etc. required for installation and maintenance of this equipment, including required warranty work, inspections as noted herein, owner training, etc., to the installing contractor upon award of the installation.
2. Install RO water treatment system and ancillary equipment per manufacturers' instructions. Turn-key installation should be provided by Reverse Osmosis water treatment/humidifier manufacturer.
3. Install with required clearance for service and maintenance.

3.2 Accessories

1. Install accessories in accordance with manufacturer's recommendations.

3.3 Commissioning

1. Start-up and commissioning of RO water treatment system and ancillary equipment should be completed by the manufacturer's field technician. 3.4 Field Test

1. A BactiQuant (BQ) Water Test, using an enzyme targeted analysis, shall be performed by a BQ Certified manufacturer's technician. The field test shall consist of, an enzyme activity which shall be measured by use of a highly sensitive fluorescence technology, and shall quantify the amount of microbial enzymes. The fluorescence signal shall be directly proportional to the content of bacteria. The BQ test shall be completed in less than 60 minutes with passed results, indicating a clean hygienic system. If test results shows BQ values higher than 57, the system must be disinfected according to manufacturer's instructions.
2.
3. The field test must be a verified method by the United States Environmental Protection Agency

(US-EPA). No Heterotrophic plate counts, nor ATP methods for bacterial test shall be accepted.

END OF SECTION 238414

SECTION 250100 - MOTOR STARTERS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. MOTOR STARTERS-GENERAL

   A. Where motor starters are required for mechanical equipment they are to be the responsibility of the Contractor furnishing the equipment as outlined herein.

   B. Motor starters shall be furnished by the Equipment Supplier with his equipment. Coordinate all requirements for starters with equipment suppliers and other trades.

   C. Motor starters shall be NEMA style. I.E.C.-style starters are not to be provided. Their sizing and installation shall be coordinated with the equipment manufacturer's requirements and in accordance with the National Electrical Code.

   D. Unless otherwise noted, provide combination starter/disconnects for all equipment requiring a starter.

2. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

   A. All mechanical equipment shall be provided for single point electrical connection unless specifically noted to the contrary. Refer to schedules and other sections of these specifications for further requirements. It is the responsibility of the Contractor to coordinate the electrical characteristics of all equipment with the electrical provisions indicated on the Contract Documents. The Contractor shall notify the Engineer in writing ten calendar days prior to bid of any discrepancy so a written clarification by Addendum may be made. If such notice is not given, the Contractor shall be responsible for any and all costs or delays associated with any changes required. Specification of equipment characteristics made during review of shop drawings shall not relieve the Contractor of this responsibility.

   B. The equipment manufacturer shall provide internally mounted fuses with his equipment, as required, to comply with the U.L. listing on the equipment name plate. (i.e., hermetically sealed compressors or equipment with name plate data that recommends or requires fuse protection.) See also, National Electrical Code, Article 440, and other applicable sections of the N.E.C.

   C. It is the Contractor's responsibility to furnish and install fusible or non-fusible disconnect switches or circuit breakers for disconnecting means as required by the Code for all electrically powered equipment. All power wiring from source, thru disconnecting means and motor starters to motor terminals or equipment junction box is to be furnished and installed by the Contractor. Each separate contractor engaged for the project shall coordinate with all other trades to ensure all necessary equipment and labor is included for fully functioning mechanical systems, installed per code requirements. Unless otherwise notes, provide combination starter/disconnects for all equipment requiring a starter.

   D. Final electrical connection of equipment shall be verified for proper voltage requirements in conjunction with the motor nameplate patch and actual wiring configuration. Any costs associated with damage to appliances motors, equipment, etc., connected to incorrect supply voltage shall be borne by the Contractor.

   E. Refrigeration condensing units with internal compressors shall be furnished with integral starter. The Contractor is to furnish and install a fusible disconnecting means with fuses sized to motor nameplate requirements. Coordinate wiring, mounting and style of disconnect switch at unit in field.

F. All interlock or other control wiring, unless specifically noted otherwise, is the responsibility of the Contractor.

G. All equipment shall be suitably enclosed. All enclosures for equipment shall be rated and approved for the environment in which it operates. (i.e., NEMA 1, NEMA 3R, NEMA 7, NEMA 12, etc.) Verify the requirement with the installation condition if not indicated on the plans.

H. Observe the following standards for manufacturers of equipment and selection of components.

(1) Starters, control devices and assemblies: NEMA, U.L. - (I.E.C. style not acceptable)

(2) Enclosures for electrical equipment: NEMA, U.L.

(3) Enclosed switches: NEMA, U.L.

(4) All electrical work, generally: National Electrical Code

(5) All electrical work in industrial occupancies: J.I.C. standards

(6) All electrical components and materials: U.L. listing required.

I. Where required, the Contractor is to provide mounting rails or channels to install starters with code-required clearances. Framing shall be solidly anchored by welding expansion shields in masonry or other approved anchorage. Frames are to be constructed of steel angles or pre-manufactured channel systems such as Unistrut, Kindorf or B-Line Company. Framing material shall be pre-finished with corrosion-resistant material or painted with two coats corrosion-resistant oil-based enamel.

3. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 1/2 H.P OR LESS

A. This section describes requirements for small mechanical equipment such as (but not limited to) package terminal heating/cooling units, (water source heat pumps, etc.) VAV boxes, unit heaters, vertical and horizontal unit ventilators, exhaust fans, in-line fans, fan coil units, cabinet heaters and the like.

B. Small equipment with motor(s) of 1/2 H.P., single phase or less are generally not required to be furnished with NEMA-style starter(s), unless otherwise noted.

C. For such equipment, provide integral contactor or horsepower-rated relay where controlled by thermostat or other type of switch. Contactors or relays shall be as recommended by the manufacturer of the equipment, suitable for the service duty.

D. Provide transformer within unit as required to derive low voltage A.C. for thermostat control or derive from temperature controls panel, if available.

E. Provide internal fusing for unit motor and other loads in fuse block or in-line fuseholder. See also Article 2-B, this Section.

F. Where externally-mounted disconnecting means is required and would be impractical, unsightly or inappropriate in the judgment of the Engineer, disconnects shall be located within the unit. These disconnects may be fusible H.P.-rated snap switches or manual starters with overload elements, as required. Locate this and other electrical equipment within enclosure where easily accessible behind

access panel or door on unit, and as acceptable to the electrical inspector or local authority having jurisdiction. Refer to mechanical equipment schedules for further information.

G. Where fractional horsepower duplex pumps such as water circulators, sump pumps, etc. are provided, they shall be provided with alternators, cordsets, etc., as required for a complete installation.

4. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 3/4 H.P. OR LARGER

A. This section describes requirements for mechanical equipment such as (but not limited to) exhaust fans, larger air handling units, cooling tower fans, water source heat pumps, chilled or hot water pumps, D.X. roof-top units, air compressors and the like.

B. Provide premium efficiency motors.

C. Equipment provided with motor(s) of 3/4 H.P. and larger, single or three-phase are required to be furnished with starters suitable for the load(s) specified. It is recommended that starters be furnished integrally with or mounted on equipment for field wiring by the Contractor. Where starters are furnished separate from equipment, furnish templates or rough-in diagrams to the appropriate contractor for his use in installation.

D. All starters shall be size 0 minimum. They shall be constructed and tested in accord with latest edition of NEMA standards. All starters shall be across-the-line magnetic type, unless indicated otherwise. On motors of 20 H.P. or greater rating, the supplier shall provide starters capable of limiting inrush currents. These shall be of the wye-delta, reduced voltage open-transition type, or electronic controlled, as required. Do not utilize closed transition starters unless specifically indicated.

E. Magnetic starters shall be furnished with the following characteristics and accessories as a minimum. See other sections of these specifications and mechanical schedules for further requirements.

(1) Contacts shall be silver-alloy, double-break type. Contacts shall be replaceable without removal of wiring or removal of starter from enclosure. Number of contacts shall be as required for service indicated. Contacts shall be gravity dropout type, positive operation.

(2) Coil voltage shall be 120 volts, A.C., 60 HZ or less, as required to suit control systems available voltages. Coils shall be of molded construction, rated for continuous duty. Provide coil clearing contact as required.

(3) Provide control transformer of adequate K.V.A. as required on all starters with line-to-line voltages higher than 120 volts A.C. Provide fuse block and slow-blow fuse to protect control transformer per NEMA, N.E.C. and U.L.

(4) Provide hand-off-auto selector switch in face of starter, wired into hand and off switch positions. Auto position (if needed) to be field wired as indicated on plans or schedules for automatic control. Provide a green run pilot light.

(5) Provide NEMA Class 20 resettable overload relays, accurately sized to the motor nameplate rating of the motor served and the temperature differential between motor and controller. Overloads shall be easily replaceable, and resettable without opening enclosure, via a push button or similar means. Class 10 or Class 30 overloads may be used, depending on the type of anticipated service.

(6) Provide at least one N.O. and one N.C. auxiliary contact (field-convertible to opposite operation) with each starter. Refer to mechanical details or schedules for additional requirements, if any. All starters shall have space for two additional single-pole contacts.

(7) All starters shall be thru-wiring type.

(8) Provide phase failure sensing relay to open starter coil circuit (on loss of one or more phases) on all three-phase starters controlling motors of 15 H.P. or larger.

(9) Provide power factor correction capacitors on motors of 15 H.P. or larger where predicted power factor based on manufacturer's data will fall below 0.90%. Capacitors shall be of the unit-cell type, in single enclosure with discharge resistors and tank overpressure circuit interrupter for safety.

5. REQUIREMENTS FOR WIRING

A. All wiring, including controls, interlock, miscellaneous power, sensors, thermostats, etc., shall be installed in metallic raceway systems that are in compliance with all Division 26 requirements of these Specifications, unless specifically noted otherwise. Open cabling systems will only be permitted where specifically permitted within the Division 26 Specifications and if less than 50 volts A.C. peak-to-peak or 50 volts maximum D.C.

B. Where open cabling is permitted, it shall be installed with proper support as specified in the Division 26 Specifications.

C. Where open cabling is permitted, and installed in environmental air plenum (return, relief, supply, etc.), the materials installed shall be in compliance with N.E.C. Articles 700, 725, 770 (for fiber optic), 780 and 800.

D. Where open cabling is permitted, it shall only be installed open in accessible spaces. Where concealed in walls, it shall be routed through raceways to outlet box(es) for the terminal device.

6. INVERTER DUTY MOTORS

A. Motors which are controlled by variable frequency drive shall be:

(1) NEMA MG-1 Part 31 rated for Inverter Duty.

(2) Furnished with shaft grounding kit for all motors:

a. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer’s instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer’s instructions. Install kit in strict accordance with manufacturer’s instructions.

b. Motors Pumps greater than 100 HP to 1000 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. Provide shaft grounding ring on drive end and non-drive end of motor per manufacturer’s instructions. Additionally, provide insulated bearing journals to further reduce risk of current

dissipation through bearings. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

END OF SECTION 250100

SECTION 26 0000

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:
   1. "Provide" or "provided" shall mean "furnish and install".
   2. "Furnish" or "furnished" does not include installation.
   3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.

G. Where architectural features govern location of work, refer to Architectural Drawings.

H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.3 RELATED WORK

A. Utility Services:
   1. Include costs for temporary service, temporary routing of service or other requirements of a temporary nature associated with utility service.

B. Temporary Services:
   1. Division 01 - Temporary Facilities and Controls.

C. Continuity of Service:

1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
2. When interruption of services is required, Architect, Owner and other concerned parties shall be notified and shall determine a time.

D. Demolition:
   1. Division 02 - Selective Demolition
   2. Perform required demolition to accomplish new work.
      a. Remove abandoned wiring to source of supply. Wiring and conduit shall be extended where necessary to maintain circuit continuity to areas beyond the demolition scope area.
      b. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
      c. Disconnect abandoned outlets and remove devices.
      d. Remove abandoned outlets if conduit servicing them is abandoned and removed.
      e. Provide blank cover for abandoned outlets that are not removed.
      f. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
      g. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
      h. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
   3. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other Contractors.
   4. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
   5. Equipment noted to be removed and turned over to Owner, shall be delivered to Owner at place and time Owner designates.
   6. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
   7. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other Contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.

E. Cleaning and Repair
   1. Clean and repair all materials and equipment that remain or are to be reused.
   2. Panelboards.
      a. Clean exposed surfaces and check tightness of electrical connections.
      b. Replace damaged circuit breakers and provide closure plates for vacant positions.
      c. Provide typed circuit directory showing revised circuiting arrangement.
   3. Luminaires:
      a. Remove existing luminaries for cleaning.
      b. Use mild detergent to clean exterior and interior surfaces; rinse with clean water and wipe dry.
      c. Replace lamps and broken electrical parts.

F. Concrete Work:
   1. Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.
   2. Concrete shall comply with Division 03 - Concrete.
   3. Provide anchor bolts, metal shapes and templates to be cast in concrete or used to form concrete as required for anchoring and supporting electrical equipment.

G. Painting:
   1. Furnish equipment with factory applied prime finish unless otherwise specified.
   2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Owner.
   3. Furnish one can of touch up paint for each final factory-applied finish coat of product.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.5 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:
   1. AEIC Association of Edison Illuminating Companies
   2. ANSI American National Standards Institute
   3. ASME American Society of Mechanical Engineers
   4. ASTM American Society for Testing and Materials
   5. BICSI Building Industry Consulting Services International
   6. EIA Electronic Industries Association
   7. FIPS Federal Information Processing Standards
   8. FCC Federal Communications Commission
   9. ICEA Insulated Cable Engineers Association
   10. IEEE Institute of Electrical & Electronics Engineers
   11. IESNA Illuminating Engineering Society of North America
   12. NEC National Electrical Code
   13. NECA National Electrical Contractors Association
   14. NEMA National Electrical Manufacturers Association
   15. NESC National Electrical Safety Code
   16. NETA National Electrical Testing Association
   17. NFPA National Fire Protection Association
   18. NIST National Institute of Standards & Technology
   19. OSHA Occupational Safety and Health Administration
   20. TIA Telecommunications Industries Association
   21. UL Underwriters Laboratories, Inc.

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 LISTING

A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.

B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.7 ENCLOSURES

A. Typical NEMA Enclosures and Usage
   1. NEMA 1 - Indoors. Falling dirt.
   2. NEMA 3R - Outdoors. Rain, snow, sleet.
   3. NEMA 4X - Outdoors. Rain, sleet, snow, wind blown dust. Hose down plus corrosion resistant.
   4. NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
   5. NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
   6. NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.

1.8 SUBMITTALS

A. Shop Drawings (Product Data):
   1. Refer to Division 01 - Submittal Procedures.
   2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
   3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
   4. Submittal tracking number is to include the respective specification number.
   5. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
   6. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
   7. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
   8. Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
   9. Include wiring diagrams for electrically powered or controlled equipment.
   10. Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and required working clearances. Submit electrical equipment room layouts concurrently with electrical distribution equipment submittals.
   11. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
   12. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
   13. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

14. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 26 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork or electrical raceway layouts.
15. Unless specifically requested in Division 26 technical sections, submittals of coordination drawings will be returned without review.

B. Certificates and Inspections:
   1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:
   1. Refer to Division 01 - Operation and Maintenance Data.
   2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
   3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
   4. Manuals shall include the following:
      a. Copies of shop drawings
      b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.
      c. CD ROM's of O&M data with exploded parts lists where available
      d. Phone numbers and addresses of local parts suppliers and service companies
      e. Internet/WEB page addresses where applicable
      f. Wiring diagrams
      g. Start up and shut down procedure
      h. Factory and field test records
      i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
   5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
   6. Furnish O&M manuals and instructions to Owner prior to request for final payment.

D. Record Documents:
   1. Refer to General Conditions of Contract and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
   2. Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.9 JOB CONDITIONS

A. Building Access:
   1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Coordination:
   1. Equipment provided under other Divisions of these specifications.
      a. Motors
      b. Electrically powered equipment
      c. Electrically controlled equipment
      d. Starters, where specified
      e. Variable frequency drives, where specified
      f. Control devices, where specified
      g. Temperature Control wiring
   2. Provide the following devices required for control of motors or electrical equipment, unless noted otherwise:
      a. Starters
      b. Disconnect devices
      c. Control devices:
         1). Pushbuttons
         2). Pilot lights
         3). Contacts
      d. Conduit, boxes and wiring for Power wiring
      e. Conduit, boxes and wiring for Control wiring, except temperature control wiring
   3. Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.
   4. Wire starters or other similar control devices furnished by others.
   5. This contractor's drawings and/or specifications show number and hp rating of motors furnished by others, together with their actuating devices. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, Contractor responsible for change shall immediately notify this Contractor. Additional costs due to these changes shall be responsibility of Contractor initiating change.
   6. Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, rain tight, explosion proof, dust tight, or any other special type as required.)
   7. Comply with local utility motor starting requirements and provide starters for motors furnished by others as specified herein or under various trade sections of those specifications.

C. Cutting and Patching:
   1. Refer to General Conditions of the Contract and Division 01 - Cutting and Patching.
   2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
   3. Provide materials required for patching unless otherwise noted.
   4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:
   1. Refer to Division 01 - Closeout Procedures.
   2. As work progresses or as directed by General Contractor, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.10 WARRANTY

A. Refer to Division 01 for general warranty requirements.

B. Refer to technical sections for warranty requirement for each system.
   1. Where no warranty requirements are called out, warrant for 1 year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.

D. In any case, wherein fulfilling requirements of any guarantee, if this contractor disturbs any work guaranteed under another contract, this contractor shall restore such disturbed work to condition satisfactory to Owner and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

B. Produce substitutions are to be approved prior to submitting bids.

C. Refer to individual specification sections for specific substitution requirements related to that section.

D. The Engineer reserves the right to refuse product substitutions after the electrical subcontract has been awarded.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Provide supplemental heat if required to prevent moisture contamination.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves above grade, interior locations unless otherwise noted.

C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.

D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 26 0593 - Electrical Systems Firestopping.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Submit drawings for approval prior to preparing openings in structural member.

H. Provide 2" clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "CS" for poured wall openings or "modular" for cored and precast wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified.

M. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for equipment shall provide access for servicing, repairs and/or maintenance.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions.

E. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

F. Verify door swings before installing room light switch boxes. Install boxes on latch side of door unless otherwise noted

3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.

C. Do not support equipment or luminaires from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.7 ELECTRICAL SYSTEMS IDENTIFICATION

A. Refer to Section 26 0553 – Electrical Systems Identification.

3.8 ACCEPTANCE TESTING

A. Contractor shall perform acceptance testing. Contractor to subcontract testing to qualified testing agency if they cannot meet the requirements of Section 26 0813. Equipment to be tested is noted as "Testing by Electrical Contractor" in technical specification sections. Perform in accordance with Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables or as outlined in technical specification sections.

B. When testing is to be witnessed by Architect/Engineer or Inspector, notify them at least 10 days prior to testing date.

C. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials.

D. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

E. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.9 START-UP

A. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.10 CLEANING

A. Clean systems after installation is complete.

B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.

C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.

D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

END OF SECTION

SECTION 26 0513.16

MEDIUM-VOLTAGE, SINGLE- AND MULTI-CONDUCTOR CABLES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 – Grounding and Bonding for Electrical Systems

B. Section 26 0543.*10* – Underground Ducts and Raceways for Electrical Systems

C. Section 26 0553 – Electrical Systems Identification

D. Section 26 0593 – Electrical Systems Firestopping

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

A. Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

B. Cables are for use in wet or dry locations, conduit, or underground duct applications.

C. Conductors shall be rated to operate at conductor temperature of 105°C for continuous normal operation, 140°C for emergency overload conditions, and 250°C for short circuit conditions, based on 40°C maximum ambient temperature.

D. Conductor sizes in Section are based on copper wire and only copper wire shall be used.

1.4 REFERENCE STANDARDS

A. AEIC CS 8 – Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46kV.

B. IEEE 48 – Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kV through 765kV.

C. IEEE 386 – Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V (ANSI).

D. IEEE 404 – Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 – 500000 V (ANSI)

E. IEEE 576 – Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications (ANSI)

F. ICEA S-93-639 – 5-46kV Shielded Power Cables for the Distribution and Transmission of Electrical Energy

G. ICEA S-94-649 – 5-46kV Concentric Neutral Cables Rated 5000 to 46000 Volts

H. ICEA S-97-682 – Utility Shielded Power Cables Rated 5000 to 46000 Volts

I. NFPA 70 – National Electrical Code

J. UL 1072 – Medium-Voltage Power Cable

1.5 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cable and cable accessories.
   1. Include cable drawings with the following data:
      a. Longitudinal cutback and cross-sectional view of cable.
      b. Identification and structure of cable components.
      c. Dimensions of cable components in English and SI units.

B. Material Certificates: For each cable and accessory type, signed by manufacturer.

C. Manufacturer Testing Certificate: For each type and voltage class of cable indicated.

D. Certified Field Quality Control Test Reports per requirements in Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables for each type and voltage class of cable indicated. Indicate applicable standards compliance. Interpret test results and corrective action taken for compliance with specification requirements.

E. Qualification Data: For testing agency.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

G. Installation Guide: Include the following:
   1. Maximum allowable pulling tension (in pounds and newtons)
   2. Minimum allowable bending radius
   3. Recommended pulling compounds
   4. Splicing and termination instructions with diagrams, dimensions, and material lists
   5. Weight per 1,000 ft.
   6. Standard "packaging" of reels (i.e., lengths, lagging, banding, etc.)
   7. Reactance and AC resistance (ohms to neutral) of each size and voltage class of cable, both in magnetic and non-magnetic duct, based on 3-1/C cables or 1-3/C cable in one duct.

H. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of cables, splices, and terminations.
   2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.6 QUALITY ASSURANCE

A. Installer: Engage cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable, having not less than 3 yrs experience as licensed electrician.

B. Regulatory Requirements:
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Source Limitations: Obtain cables and accessories through one source from single manufacturer.

D. All cables shall be of a single type and configuration. Date of manufacture shall not precede contract date by more than one year.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Coordinate with manufacturer to provide protective covering over cable and reel to prevent damage during shipping, storage, or handling.

B. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cables:
1. General Cable / Prysmian Group
2. Okonite Company
3. Southwire Company
4. ~~Aetna Insulated Wire Company~~

B. Cable Splicing and Terminating Products and Accessories:
1. Raychem Corporation
2. RTE Components; Cooper Power Systems, Inc.

3. Prysmian Group
4. Thomas & Betts Corporation/Elastimold
5. 3M; Electrical Products Division
6. Approved equal

2.2 CABLES

A. Cable Type: MV105

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682

C. Conductor: Copper

D. Conductor Stranding: Compact round, concentric lay, Class B

E. Strand Filling: Conductor interstices are filled with impermeable compound

F. Conductor Insulation: Ethylene-propylene-rubber (EPR)

G. Voltage Rating: 15kV

H. Insulation Thickness: 133 percent insulation level

I. Shielding: Copper tape, helically applied over semiconducting insulation shield. ~~12.5~~25% overlap ~~for 15KV and less, 25% over 15KV~~..

~~J. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket~~

~~K.~~J. Cable Jacket: Chlorinated polyethylene, CPE. Color: black, unless otherwise designated

~~L.~~K. Cables utilizing combination insulation shield and jacket are acceptable.

~~M.~~L. Cable lengths shall be supplied with factory-installed, moisture-proof end seals on conductors on each end. Cable seals shall be rubber or plastic caps, and shall prevent moisture from seeping into cable ends.

~~N.~~M. Each cable reel shall be tagged with the following:

1. Manufacturer
2. Cable Size
3. Cable Type
4. Voltage Class
5. Manufacture Date
6. Cable Length
7. Tolerances
8. Reel Number
9. Customer Order No.
10. Customer Name

~~O.~~N. Surface Marking:

1. Cables shall be permanently printed (or imprinted) on jacket surface at regular intervals over entire length of cable with the following:
   a. Manufacturer's name
   b. Conductor size
   c. Voltage class
   d. Insulation type
   e. UL designation

~~P.~~O. Cables shall be constructed and rated for continuous and intermittent submersion in water and shall be suitable for installation in conduit and underground duct.

~~Q.~~P. Cable shield shall be capable of withstanding fault current indicated on drawings for 1/10 second.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include components required for complete splice, with detailed instructions.
   1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
   2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
   3. Premolded, cold-shrink-rubber, in-line splicing kit.
   4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
   1. Class 1 Terminations: Modular type, furnished as kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
   2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
   3. Class 1 Terminations: Modular type, furnished as kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules, shield ground strap; and compression-type connector.
   4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
   5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
   6. Class 3 Terminations: Kit with stress cone and compression-type connector.

B. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

C. Cable Terminations:
   1. Product of one manufacturer and furnished in kit form compatible with insulation and conductor material for cable terminated.

D. Connecting Lugs:
   1. Connectors and terminals: Copper with uniform compression over entire contact surface.
   2. Terminals on conductors: Solderless terminal lugs.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with **200A or 600A (refer to drawings)**, 15 KV class, 95 KV BIL load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated, with steel-reinforced hook-stick eye, grounding eye, and arc-quenching material. Include capacitance coupled test point on terminator body. Include cold shrinkable metallic shield adapter kit to ground metallic shielded cable. Include connection bus with parking stand for wall mounting.

D. Dead-Break Cable Terminators: Elbow-type unit with 600A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: **200A or 600A (refer to drawings)**, 15 KV class, modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
   3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
   4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Pont Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

~~G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.~~

~~2.6~~2.5 ARC-PROOFING MATERIALS

A. Tape for First course on Metal Objects: **0.254 mm(10 mil)**-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to **8 mm(0.3")** thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive tape, **13 mm(1/2")** wide.

~~2.7~~2.6 SOURCE QUALITY CONTROL

A. Test and inspect cables according to Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended minimum installation temperature, maximum pulling tensions, and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
   2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
   3. Cut off cable damaged by cable grips or pulling make-ups so as to provide clean, undamaged cable for termination. Continuously record pulling tension during installation.
   4. Make attachment to cable by compression or epoxy filled pulling eye and provide break away (clutch) tension device.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
   1. Support cables and conductors in vertical raceways per requirements in Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Install "buried-cable" warning tape per requirements in Section 26 0553 - Electrical Systems Identification.

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by longest route from entry to exit and support cables at intervals adequate to prevent sag. Fill lowest ducts first, avoid covering or blocking duct entrances and allow space for future cable installation.

F. Cut cable in clean, dry environment. Seal cut ends with waterproof seal immediately after cutting. Maintain a seal during and after pulling.

G. Install cable splices at pull points (accessible locations) and elsewhere as indicated; use standard kits.

H. Install terminations at ends of conductors and seal multi-conductor cable ends with standard kits. Do not install exterior terminations during inclement weather or damp atmospheric conditions.

I. Install stress cones at cable splices and terminations, grounded per cable and connector manufacturer recommendations.

J. Check phase rotation before connections are made to existing circuits. Clearly letter cable terminations. Identify phases with phase designations lettered on terminal boxes and other terminations throughout the system.

~~K. Install separable insulated-connector components as follows:~~

~~1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected~~

~~2. Portable Feed-Through Accessory: Three~~

~~3. Standoff Insulator: Three~~

~~L.~~K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape and/or manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10 mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1"-wide bands of half-lapped, adhesive, glass-cloth tape 2" o.c.

~~M.~~L. Seal around cables passing through fire-rated elements according to Section 26 0593 – Electrical Systems Firestopping.

~~N.~~M. Install fault indicators on each phase where indicated.

~~O.~~N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Shields shall be grounded at both ends of cable run. Single point grounding will not be accepted. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware. For grounding requirements, refer to Section 26 0526 – Grounding and Bonding for Electrical Systems.

~~P.~~O. Identify cables according to Section 26 0553 – Electrical Systems Identification.

3.2 FIELD QUALITY CONTROL

A. Perform cable acceptance tests on cable circuits after installing cables and before electrical circuitry has been energized. Splices and terminations required as part of this project are to be completed and acceptance tested as part of cable tests. For cables not spliced or terminated as part of project, ends should be clean, dry and long enough to eliminate leakage from conductor to ground along outer surface of cable.

B. Perform acceptance tests and damage investigations under constant supervision of Owner's representative. Contractor shall coordinate and provide labor, material, equipment, and services necessary to test each completed cable circuit.

C. Remove and replace defective cables and retest as required.

D. Refer to Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables for visual and mechanical inspection and electrical tests. Certify compliance with test parameters.

END OF SECTION

SECTION 26 0516

OWNER-FURNISHED EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Section includes installation and testing of owner-purchased pieces of equipment, which are required in construction.

B. Owner-furnished equipment requiring work by Contractor is specified in the following Sections:
   1. Section 26 1116 - Secondary Unit Substations
   2. Section 26 1216 - Dry-Type, Medium-Voltage Transformers
   3. Section 26 1316 - Medium-Voltage Fusible Interrupter Switchgear
   4. Section 26 2200 - Low-Voltage Transformers
   5. Section 26 2300 - Low-Voltage Switchgear
   6. Section 26 2313 - Paralleling Low-Voltage Switchgear
   7. Section 26 2413 - Switchboards
   8. Section 26 2416.13 - Lighting and Appliance Panelboards
   9. Section 26 2416.16 - Distribution Panelboards
   10. Section 26 2416.19 - Isolation Panelboards
   11. Section 26 2500 - Enclosed Bus Assemblies
   12. Section 26 2550 - Generator Docking Station
   13. Section 26 2713 - Electrical Metering
   14. Section 26 2813 - Fuses
   15. Section 26 2816 - Enclosed Switches and Circuit Breakers
   16. Section 26 2913 - Enclosed Controllers
   17. Section 26 3213 - Diesel Engine Generators
   18. Section 26 3623 -Automatic Transfer Switches
   19. Section 26 4300 - Surge Protective Devices

C. Contractor shall be responsible for receipt of equipment from Owner, storage after receipt, installation, and electrical connection.

D. Owner-furnished equipment requiring work by the Contractor is shown on the drawings and schedules.

E. Owner-furnished, Contractor-installed equipment is labeled OFCI.

1.3 SUBMITTALS

A. Shop Drawings: Owner-supplied shop drawings of equipment furnished by Owner.

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.6 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide labor, materials and electrical connections for Owner-furnished equipment in accordance with contract drawings.

B. Install and connect Owner-furnished equipment as though it had been purchased by Contractor.
   1. This shall include:
      a. Receiving equipment at jobsite
      b. Rigging and setting equipment in place
      c. Making electrical connections
      d. Starting
      e. Testing

C. Install equipment in accordance with manufacturer's installation instructions.

D. Maintain equipment until facility is accepted by Owner.

E. Review Owner-supplied shop drawings of Owner-furnished equipment to ascertain that necessary labor and materials have been provided to install equipment and complete the system it serves.

END OF SECTION

SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0529 - Hangers and Supports for Electrical Systems

B. Section 26 0553 - Electrical Systems Identification

C. Section 26 0593 - Electrical Systems Firestopping

D. Section 26 0812 - Power Distribution Acceptance Tests

E. Section 26 0813 - Power Distribution Acceptance Test Tables

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations rated 600 V and less, sleeves and sleeve seals for cables.

B. Conductor and conduit sizes in these contract documents are based on copper wire, and only copper wire shall be used.

1.4 REFERENCE STANDARDS

A. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

B. ASTM B 1 – Standard Specification for Hand-Drawn Copper Wire.

C. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

D. NEMA WC 3 – Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-19-81).

E. NEMA WC 5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-61-402).

F. NEMA WC 70 – Non-Shielded Power Cable 2000 V or less for the Distribution of Electrical Energy (ICEA S-95-668).

G. NFPA 70 – National Electrical Code.

H. UL 44 – Thermoset-Insulated Wires and Cables.

I. UL 83 – Thermoplastic-Insulated Wires and Cables.

J. UL 486A-486B – Wire Connectors.

K. UL 486C – Splicing Wire Connectors.

L. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.

M. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

N. UL 2196 – Standard for Tests for Fire Resistive Cables

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of components and circuits.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

B. Wire and cable boxes and reels shall bear the date of manufacture.
   1. Date of manufacture shall not precede contract date by more than one year.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cerrowire

B. General Cable Corporation

C. Prysmian Group - Draka

D. Senator Wire & Cable Company

E. Southwire Company

2.2 DESCRIPTION

A. NEMA WC 70; single copper conductor insulated wire; 600V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.
   1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THWN, THHW.
   2. Thermoset-insulated wires and cables: NEMA WC 3, UL 44; Type XHHW-2.
   3. Thermoset-insulated wires and cables: FT4, UL 2196, UL44; Type RHW-2.

2.3 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1
   1. Copper conductor, single insulated wire.
   2. Insulation type THHN, THHW rated 90°C, 600 V insulation class.
   3. Type XHHW-2 for ambient temperature less than 32°F.
   4. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.

B. Classes 2 and 3
   1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
   2. Insulation type XLE, rated 105°C, 300 V insulation class.
   3. UL listed for use in space in which circuits will be installed.

2.4 CONNECTORS, SPLICES, AND TERMINALS

A. Manufacturers:
   1. AFC Cable Systems, Inc.
   2. Burndy Division of Hubbell Incorporated
   3. Hubbell Power Systems, Inc.
   4. Ideal Industries, Inc.
   5. O-Z/Gedney; EGS Electrical Group LLC.

6. 3M; Electrical Products Division
7. Thomas and Betts Division of ABB
8. Tyco Electronics Corp.

B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.5 TERMINATIONS

A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.6 PLASTIC CABLE TIES

A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

A. Install conductors in a raceway system, unless otherwise specified or indicated.

B. Install conductors only after:
1. Building interior is enclosed and weather tight.
2. Mechanical work likely to damage conductors has been completed.
3. Raceway installation is complete and supported.

C. Pull conductors into raceway at same time.

D. Neatly train and lace conductors inside boxes, equipment, and panelboards.

E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

F. 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. Do not use pulling compound on branch circuit conductors served by grounding isolation panelboards.
1. Lubricants shall be UL Listed

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

H. Provide adequate support for conductors not in raceway. Do not support conductors from ceiling grid or from accessible ceiling support systems.

I. Support conductors in vertical raceways using OZ type "S" cable supports for 600 volt conductors.

J. Support conductors above 600 volts in vertical raceways using OZ type "R" cable supports.

K. Support cables and conductors in vertical raceways per requirements in Section 26 0529 - Hangers and Supports for Electrical Systems.

L. Identify and color-code conductors and cables according to Section 26 0553 - Electrical Systems Identification.

M. Wiring at Outlets: Install conductor at each outlet, with minimum 12” of slack.

N. Limit conduit fill to a maximum of 9 current-carrying conductors.

O. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under terminal screws.

P. Install VFD input wiring, output wiring and control wiring in their own separate conduit systems.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders and Branch Circuits: Solid #12 AWG and smaller; stranded for #10 AWG and larger.

B. Minimum conductor sizes shall be as follows:
1. #12 AWG – Branch circuits of any kind.
2. #14 AWG – Remote control and signal systems, fire alarm system.
3. #10 AWG - Exit light circuits, emergency circuits, security lighting

C. Branch wiring length limitations:
1. 208Y/120 V circuits over 100’ in length: Increase wire size one size for each 100’ of length. Increase conduit size as required.
2. 480Y/277 V circuits over 150’ in length: Increase wire size one size for each 150’ of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders: Type THHW, THWN, XHHW-2, rated 75°C for wet locations, single conductors in raceway.

B. Branch Circuits: Type THHN, XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.

C. 2-Hour Fire Resistive Cables: Type RHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway. Classified to UL 2196.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh strain relief device at terminations to suit application.

E. Motor Circuit Branch Wiring Between Motor and VFD: XHHW-2

3.4 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Sizing – #14 AWG minimum.

B. Installation:
1. Install cables in cable tray and cable rings.
2. Provide protection for exposed cables where subject to damage.
3. Support cables above accessible ceilings; do not rest on ceiling tiles.

4. Use suitable cable fittings and connectors.

3.5 CONNECTORS, SPLICES AND TERMINALS

A. Connectors:
   1. Aluminum and aluminum alloy connectors are not allowed to be used.
   2. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
   3. 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-486B.
   4. Joints, taps and splices sizes No. 10 and smaller:
      a. Ideal-Nut Connectors or Scotchlok Spring connectors
   5. Joints, taps and splices sizes No. 8 and larger:
      a. Copper compression connectors
         1) Install with hydraulic compression tool.
   6. Joints, taps and splices sizes larger than No. 1:
      a. Tape with electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half lapped layers of plastic electrical tape.

B. Splices:
   1. Splice wires and cable only in accessible locations such as within junction boxes.
   2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
   3. Splices are to be made with compression barrel connector where no taps exist or allowance for future taps is being made.
   4. Where the splice includes provisions for taps, use Burndy insulated Unitap. Locate in pull or junction box sized for all conductors to be spliced and tapped.
   5. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
   6. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
   7. Plastic snap-on or piercing type mechanical splice insulators are not allowed.
   8. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Terminals:
   1. All terminals are to be compression type.
   2. Train wires to eliminate fanning of stands, crimp with proper tool and die.
   3. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
   4. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
   5. Torque screw termination per manufacturer's recommended values.
   6. Terminate motors connections using the following methods:

a. 300V and below: Use compression-set, insulted eye terminal for screw lug connections or barrel type cable to cable connections.

b. Above 300V: Use 3M 5300 series insulated motor lead splicing kit.

3.6 CABLE TIES

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.7 FIELD QUALITY CONTROL

A. Testing by Testing Agency.

B. Test 600-volt conductors and cables per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Perform electrical acceptance testing on 600-volt feeders serving panelboards, switchboards and secondary voltage service entrance equipment.

1. Acceptance testing shall include the following:

a. Verify tightness of accessible bolted connections.

b. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors.

1) Applied potential to be 1000 volts DC for one minute.

2) Minimum insulation resistance shall be 50 megohms.

3) Correct deviations between adjacent phases and values below minimum.

c. Perform continuity test to insure correct cable connection.

D. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0812 - Power Distribution Acceptance Tests

B. Section 26 0813 - Power Distribution Acceptance Test Tables

C. Section 26 4113 - Lightning Protection for Structures

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein.
   1. Common ground bonding with lightning protection system.

B. Maximum resistance to ground shall be less than 5 ohms.

1.4 REFERENCE STANDARDS

A. TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

B. ASTM B 3 – Specification for Soft or Annealed Copper Wire

C. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft

D. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

E. IEEE C2 – National Electrical Safety Code (ANSI)

F. NETA MTS – Maintenance Testing Specifications

G. NFPA 70 – National Electrical Code

H. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

I. NFPA 780 – Lightning Protection Systems

J. UL 96 – Lightning Protection Components

K. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field Quality-Control Test Reports:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
   2. Test reports of resistance to earth. Each test report shall include:
      a. Date of test, soil moisture content, and soil temperature
      b. Test operator
      c. Instrument or other test equipment used
      d. Electrode designation or location
      e. Ground impedance in ohms
      f. Assumptions made - if required

C. Closeout Submittals:
   1. Operation and Maintenance Manuals: Include the following:
      a. Instructions for periodic testing and inspection of grounding system.
         1) Instructions to perform tests to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
         2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
   2. Comply with UL 467 for grounding and bonding materials and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Counterpoise and Bonding Conductor: Bare stranded conductor, size as indicated on drawings.

C. Grounding Bus: Horizontal rectangular bars of annealed copper, 1/4” by 2” in cross section; with insulators, length as indicated on drawings. Minimum length is 24”.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory 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, bolted 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.

D. Compression Connectors: Irreversible type.
   1. Manufacturer: Burndy YGA Series or Approved Equal

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, 3/4” in diameter by 10 ft in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Exposed Bonding Conductors: Install solid conductor for #6 AWG and smaller and stranded conductors for #4 AWG and larger, unless otherwise indicated.

B. Equipment Grounding Conductors: Install solid conductor for #12 AWG and smaller and stranded conductors for #10 AWG and larger. Conductors are to have green insulation for #10 AWG and smaller and identified with green tape at terminations, boxes and splices for sizes #8 AWG and larger.

C. Underground Grounding Conductors: Install bare copper conductor. Sized as indicated on drawings.

1. Bury at least 24” below grade.
2. Ductbank Grounding Conductor: Bury 12” above ductbank when indicated as part of ductbank installation.

D. Grounding Bus: Install in electrical and communications rooms, in rooms housing service equipment.
   1. Install bus on insulated spacers 1”, minimum, from wall; 6” above finished floor in locations as indicated on drawings.

E. 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 Ground Rods at Test Wells: Bolted connectors
   4. Connections to Structural Steel: Welded connectors

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with feeders and branch circuits. Install for each branch circuit neutral originating from panelboards, including lighting circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   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

C. Water Heater, Heat-Tracing, and Antifrost 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. Duplex receptacles of any amperage: Install separate jumper between grounding terminal on device and metallic box.

E. Size of equipment grounding conductors for branch circuits: As indicated in NFPA-70, except minimum size shall be #12 AWG.

F. Size of branch panel feeder originating at switchboards/switchgear: As indicated in NFPA-70, except in no instance smaller than #8 AWG.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, install insulated grounding conductor (sized as indicated on drawings) in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Telecom Grounding Bus: Terminate grounding conductor on grounding bus located in telecom room.
2. Terminal Cabinets: Bond cabinet grounding terminal to telecom grounding bus.
3. Cable Tray: Bond cable tray to telecom grounding bus.

H. Install grounding conductor from each standby-emergency generator to grounding electrode system. Provide flexible jumper between base and isolated generator.

I. Install equipment grounding conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.

J. Install grounding for service entrance equipment room consisting of ground bus, ground conductors, and copperclad grounding rods arranged as indicated on drawings.

K. Install grounding conductor to luminaires hanging form conduit swivel hangers.

3.3 SEQUENCING, SCHEDULING

A. Permanently attach service grounds before permanent building service is energized.

B. Permanently attach equipment grounds prior to energizing equipment.

3.4 INSTALLATION

A. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.

B. Identify all grounding conductors by system and room number of termination at building grounding electrode point.

C. 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.

D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

E. Ground Rods: Install ground rods with the top 1 ft minimum below finished grade.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

F. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12” deep, with cover.
1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor. Connections within well are to be reversible mechanical type.

G. 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 so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. 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, using a bolted clamp connector or by bolting 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. Water pipe, by itself, is not an adequate grounding electrode and must be supplemented by another electrode system. Bond system together.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

I. Bond medical gas piping at point of origin and at each floor of distribution to service entrance grounding bus bar.

J. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

K. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.

L. Ground Ring: Install a grounding conductor, electrically connected to building structure ground rod and to each indicated item, extending around the perimeter of area or item indicated on drawings.

M. Equipment Grounding Conductor: Terminate in panelboard at green wire ground bus.

N. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.

O. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

3.5 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
1. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells. Make tests at ground rods before any conductors are connected.

B. Test grounding systems per requirements in Section 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Inspect completed system by commissioning authority, prior to backfilling.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0533 – Raceway and Boxes for Electrical Systems

B. Section 26 1216 – Dry-Type, Medium-Voltage Transformers

C. Section 26 1316 – Medium-Voltage Fusible Interrupter Switchgear

D. Section 26 2200 – Low-Voltage Transformers

E. Section 26 2300 – Low-Voltage Switchgear

F. Section 26 2313 – Paralleling Low-Voltage Switchgear

G. Section 26 2413 – Switchboards

H. Section 26 2416.13 – Lighting and Appliance Panelboards

I. Section 26 2416.16 – Distribution Panelboards

J. Section 26 2419 – Motor-Control Centers

K. Section 26 2500 – Enclosed Bus Assemblies

L. Section 26 2816 – Enclosed Switches and Circuit Breakers

M. Section 26 2913 – Enclosed Controllers

N. Section 26 3213 – Diesel Engine Generators

O. Section 26 3623 – Automatic Transfer Switches

P. Section 26 5100 – Lighting Systems

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes the following:

1. Manufactured hangers and supports for individual raceways and cables, slotted channel and angle systems for multiple conduit runs, and most electrical equipment that is not floor mounted.

2. Construction requirements for concrete housekeeping pads for floor-mounted electrical equipment.

1.4 REFERENCE STANDARDS

A. AWS D1.1/D1.1M – Structural Welding Code-Steel.

B. ASTM A 36/A 36M – Carbon Structural Steel.

C. ASTM A 325 – Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

D. ASTM A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

E. MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.

F. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.

G. MFMA-4 – Metal Framing Standards Publication.

H. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.

I. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).

J. NFPA 70 – National Electrical Code.

K. SSPC-PA 1 – Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Raceway and cable supports.
   3. Support for conductors in vertical raceway.
   4. Structural steel for fabricated supports and restraints.
   5. Mounting, anchoring, and attachment components:
      a. Powder-actuated fasteners.
      b. Mechanical-expansion anchors.
      c. Concrete inserts.
      d. Clamps for attachment to structural steel.
      e. Through bolts.
      f. Toggle bolts.
      g. Hanger rods.

B. Shop Drawings: Include concrete anchors application, size, and placement. Include concrete inserts application, size, loading, and placement. Show fabrications 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. Fabricated metal equipment support assemblies.

C. Welding certificates.

D. Schedule of hangers and support devices with support spacing.

1.6 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

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. 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 5 times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Finishes
      a. Metallic Coatings:
         1) Factory standard primed, galvanized of electroplated finish and applied according to MFMA-4, for indoor applications.
         2) Hot-dip galvanized after fabrication and applied according to MFMA-4, for outdoor applications.
      b. Painted Coatings: Manufacturer’s standard painted coating applied according to MFMA-4.
   2. Channel Dimensions: Selected for applicable load criteria.
   3. Manufacturers:
      a. Allied Support Systems; Power-Strut Unit.
      b. Cooper B-Line, Inc.; A division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corporation.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
      h. National Pipe Hanger Corporation.
      i. Michigan Hanger Co., Inc.; O-Strut Division.
      j. Approved equal.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Raceway and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Raceway: 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 suite individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. 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. Manufacturers:
         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
         5) Approved equal
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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. Manufacturers:
         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.
         6) Approved equal
   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:
      a. MSS SP-58; threaded steel, with adjusting and lock nuts; electroplated zinc finish.
      b. MSS SP-58; nonmetallic, with adjusting and lock nuts.

2.2 FABRICATED METAL FRAMING 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; not be lighter than 12 gauge.

C. Finish: Electro-galvanized.

D. Manufacturers: Same as in paragraph 2.1.B.3 above.

2.3 CONTINUOUS INSERT CHANNELS

A. Length and support capabilities to be suitable for application.

B. Brackets, inserts and accessories suitable for channel insert selected.

C. Manufacturers:
1. Unistrut; Tyco International, Ltd.
2. Cooper B-Line, Inc.; A division of Cooper Industries
3. Michigan Hanger Co., O-Strut Division
4. Anvil International, Inc.
5. Approved equal

PART 3 - EXECUTION

3.1 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.
1. Size steel hanger rods for individual hangers and trapeze supports as indicated in the following schedule. Total weight of equipment shall not exceed limits indicated.

Maximum Loads (lbs)	Rod Diameter (")	Maximum Pipe Size With Single Rod
730	3/8	2"
1130	1/2	3"
1818	5/8	5"

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2" and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in paragraphs below.

B. Raceway Support Methods: In addition to methods described in NECA 1, raceways 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” thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4” thick.
   6. To Steel: Spring-tension clamps or beam clamps.
   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.

F. Do not support raceway by other raceway.

G. Do not support equipment or raceway from metal roof decking or floor decking.

H. Do not impose weight of electrical equipment, raceways, or lighting fixtures on support provided for other trades or systems.

I. Do not support loads from bottom chord member of trusses or open web chord.

J. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

K. Use conduit-mounting pedestals for piping on roof. Install bottom of pedestal flat on roof deck and insulate exterior of pedestal, flush and counter flush. Coordinate roof mounting methods with roof system installer to maintain roof warranty provided by roof system installer.

L. Minimize use of concrete anchors and inserts after concrete pour.

M. Punching, drilling, welding of building structural steel or welding attachment to building structural steel is not allowed, unless approved by structural engineer.

3.3 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.

3.4 CONCRETE HOUSEKEEPING PADS

A. Construct concrete housekeeping pads for all floor-mounted electrical equipment.

B. Dimensions: 4” high and not less than 4” larger in both directions than supported equipment, so anchors will be a minimum of 10 bolt diameters from edge of the base.

C. Provide #4 steel reinforcement bars on 12” centers horizontally in both directions. Center the reinforcement vertically between the floor and the top of the pad, supported on chairs.

D. Dowel #4 reinforcement steel into existing floor slab using concrete epoxy.

E. Prepare existing concrete slab under equipment pad by rough grinding surface and applying latex concrete bonding agent.

F. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section “Cast-in-Place Concrete.”

G. Anchor equipment to concrete housekeeping pad.
   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.

H. Coordinate with Architect installation of housekeeping pads on roof.

3.5 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 minimum dry film thickness of 2.0 mils.

END OF SECTION

SECTION 26 0533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0593 – Electrical Systems Firestopping

F. Section 26 2726 – Wiring Devices

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes raceways, fittings, wireways, wall ducts, indoor service poles, outlet boxes, pull and junction boxes, floor boxes, tap boxes and raceway seals.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. ANSI C80-1 – Rigid Steel Conduit-Zinc Coated (GRS)

C. ANSI C80-3 – Electrical Metallic Tubing-Zinc Coated (EMT)

D. ANSI C80-6 – Intermediate Metal Conduit-Zinc Coated (IMC)

E. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

F. ETL PVC-001 – Intertek ETL SEMKO High Temerature H^2O PVC Coating Adhesion Test Procedure for 200hrs.

G. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)

H. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

I. NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

J. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

K. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit

L. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

M. NFPA 70 – National Electrical Code

N. UL 1 – Flexible Metal Conduit

O. UL 6 – Electrical Rigid Metallic Conduit-Steel

P. UL 360 – Liquid-Tight Flexible Steel Conduit

Q. UL 514A – Metallic Outlet Boxes

R. UL 514B – Conduit, Tubing, and Cable Fittings

S. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings

T. UL 797 – Electrical Metallic Tubing-Steel

U. UL 870 – Wireways, Auxiliary Gutters, and Associated Fittings

V. UL 1242 – Electrical Intermediate Metal Conduit-Steel

W. UL 1660 – Liquid-Tight Flexible Nonmetallic Conduit

1.5 SUBMITTALS

A. Product Data:
   1. Raceways
   2. Fittings
   3. Wireways
   4. Indoor service poles
   5. Outlet boxes
   6. Pull and junction boxes
   7. Floor boxes
   8. Tap boxes
   9. Raceway seals

B. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

C. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual routing of raceways 2” and larger.

b. Record actual location and mounting heights of wireways, indoor service poles, floor boxes, tap boxes, outlet, pull and junction boxes.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Protect PVC conduit from sunlight.

C. Comply with manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC)

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel, PVC coated where specified on drawings: NEMA RN 1 and verified by ETL to ETL PVC-001.

B. Intermediate Metal Conduit (IMC): ANSI C80.6, UL 1242; thinner wall, galvanized steel, PVC coated where specified on drawings: NEMA RN 1 and verified by ETL to ETL PVC-001.

C. Fittings (couplings, conduit bodies, connectors and bushings): NEMA FB 1, UL 514B; aluminum alloy; threaded; connectors with double locknuts and steel insulating bushings, thermoplastic insulating bushings; conduit bodies cover: stamped steel, with stainless steel screws and neoprene gaskets, PVC coated where PVC coated conduit is used.

D. Fittings Manufacturers: Cooper Crouse-Hinds; Carlon Electric Products; O-Z/Gedney; Appleton; Hubbell; Robroy Industries – Perma-Cote.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. ANSI C80.3, UL 797; galvanized steel tubing

B. Fittings (couplings, conduit bodies, and connectors): NEMA FB I, UL 514B; steel, watertight gland compression type connectors with double locknuts and insulated throat; conduit bodies cover: stamped steel, with stainless steel screws and neoprene gaskets. Indentor, drive-on, die-cast or pressure cast fittings not permitted.

C. Fittings Manufacturers: Same as manufacturers listed in 2.1.D.

2.3 FLEXIBLE METAL CONDUIT (FMC)

A. UL 1; interlocked steel

B. Fittings: NEMA FB I, UL 514B; steel, squeeze-type (screw on are not acceptable) or Tomic twist-in type in sizes not exceeding 3/4".

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. UL 360; interlocked steel, with PVC jacket

B. Fittings: NEMA FB 1, UL 514B; steel, waterproof

C. Type: UA

2.5 RIGID NONMETALLIC CONDUIT (RNC)

A. NEMA TC 2, UL 651; Schedule 40 or 80 (as indicated) PVC, 90C rated. Material must have tensile strength of 7,000 psi at 73.4 deg. F., flexural strength of 11,000 psi and compressive strength of 8,000 psi

B. Fittings: NEMA TC 3, UL 651

2.6 METAL WIREWAYS

A. NEMA 250, UL 870; galvanized sheet metal troughs with hinged or removable cover, Type 1 for indoor and 3R for outdoor, unless otherwise indicated.

B. Size: cross section and length as indicated on drawings.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mated with wireways as required for complete system.

D. Wireways Covers: Screw-cover type for indoor, flanged-and-gasketed type for outdoor.

E. Knockouts: none.

F. Finish: Manufacturer's standard enamel finish

G. Manufacturers: Same as listed in Section 2.9F.

2.7 INDOOR SERVICE POLES

A. Description: Freestanding, two compartments utility columns with receptacles for power branch circuits and provisions for communication outlets.

B. Materials: Main Body: Steel; cover plates: steel.

C. Accessories: Trim plates for closing ceiling opening; fittings available as standard accessories; foot: suitable for floor finish as indicated on drawings; top clamp: concealed, designed to fasten pole to inverted "T" grid ceiling suspension member.

D. Finish: as specified by Architect.

E. Manufacturers: Wiremold; Approved equal

2.8 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A; galvanized steel with stamped knockouts.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; 1/2" male fixture studs, where required
   2. Concrete Ceiling Boxes: Concrete type

B. Cast-Metal Outlet Boxes: NEMA FB 1, cast aluminum or cast iron (galvanized), Type FD, with gasketed cover and threaded hubs

C. Gangable type boxes are not allowed

D. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Approved equal

2.9 PULL AND JUNCTION BOXES

A. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1; galvanized steel

B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1; cast aluminum or galvanized, cast iron with ground flange, gasketed cover and stainless steel cover screws

C. Minimum size: 4" square by 2-1/8" deep for use with 1" conduit and smaller; 4-11/16" square by 2-1/8" for use with 1-1/4" conduit and larger

D. Masonry type boxes shall be used in masonry walls.

E. Sheet Metal Boxes Larger Than 12" in any direction: Hinged cover or a chain installed between box and cover.

F. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.

G. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Hubbell-Weigmann; Hoffman; J&A Sheet Metal Inc. Austin Electrical Enclosures; Approved equal

2.10 FLOOR BOXES

A. Metal Floor Boxes: NEMA OS1; cast metal; fully-adjustable; Moisture-proof, with forged brass blank cover with each box and close up covers and/or carpet flanges as required for finished floor.

B. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
   1. Fire Rating: 2hr
   2. Service Fitting Type: Flush
   3. Housing: brass flanges, flush with floor
   4. Configuration: as indicated on drawings
   5. Manufacturers: Hubbell; LeGrand

2.11 EXPANSION FITTINGS

A. Malleable iron, hot dip galvanized allowing 4" allowing 2" raceway movement.

B. Manufacturers: OZ/Gedney AX Series; or equivalent by manufacturer listed in 2.1.D.

2.12 RACEWAY PENETRATION SEALS

A. Thruwall and Floor Seals.

B. Manufacturers: New construction – OZ/Gedney FSK Series; existing construction – OZ/Gedney CSM Series; or equivalent by manufacturer listed in 2.1.D.

2.13 RACEWAY SEALING FITTINGS

A. For one through four conductors: Manufacturers: OZ/Gedney CSB Series; Approved equal

B. For greater than four conductors: Manufacturers: OZ/Gedney EYA Series with sealing compound; Approved equal

C. Low-temperature or hazardous locations: Manufacturers: OZ/Gedney EYA Series with sealing compound; Approved equal

2.14 CABLE SUPPORTS

A. Manufacturers: OZ/Gedney Type S; or equivalent by manufacturer listed in 2.1.D.

2.15 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with integral water stop.

B. Integral Water Stop: Manufacturer: Thunderline Corporation; Approved equal
   1. High density polyethylene (HDPE). Type Century-Line engineered sleeve with end caps.
   2. Steel. Type WS engineered sleeve.

2.16 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Carbon steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate with Architect/Engineer size and location of required built-in openings in building structure, including those sleeved, formed or core drilled.

B. Coordinate with Architect/Engineer cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.

C. Verify with Architect/Engineer all surface raceway installations except in mechanical, electrical, and communications rooms.

D. Coordinate with Architect/Engineer exact locations of floor boxes, where shown on drawings, prior to rough-in.

E. Coordinate routing of any through-wall or through-roof conduits.

F. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0593 – Electrical Systems Firestopping.

G. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.

H. Verify with manufacturer that “touch-up” paint kit **[and PVC-coating kit]** are available for use.

3.2 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway’s installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Raceways:
   1. Comply with ANSI/NECA 1 and NFPA 70 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.
   2. PVC-coated raceways are to be installed by factory trained installers to factory installation standards and recommendations.
   3. Arrange raceways to maintain headroom and present neat appearance.
   4. Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation.
   5. Keep raceways at least 12”away from parallel runs of fuels, steam, hot-water pipes or ductwork. Install horizontal raceway runs above water and steam piping. Install raceways level and square and at proper elevations: 6’-6” minimum headroom, except in exit pathways 7’-0” minimum headroom. Do not block access to junction boxes, mechanical equipment or prevent removal of ceiling panels, etc.
   6. Run raceways concealed in construction to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid materials and equipment of other trades, except where noted otherwise.
   7. Avoid exposed raceway runs. Run raceways exposed in mechanical and electrical rooms, or with specific approval in writing (from UK project manager) is obtained or specifically indicated. Run exposed raceways grouped and parallel or perpendicular to construction. Do not route exposed raceways over boilers or other high-temperature machinery or in contact with such equipment. Offset exposed raceways at boxes.
   8. Route raceways installed above accessible ceilings parallel or perpendicular to construction.
   9. Do not install raceways in structural or topping floor slabs, except where noted on the plans. Install raceway in structural or topping floor slabs, where noted on plans, as follows:
      a. Center raceways in structural slabs clear of reinforcing steel, except where crossing same, and spaced on centers equal or exceeding 3 times the raceway diameter. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in concrete.
      b. Outside diameter of raceway shall not exceed 1/3 the structural slab thickness.
      c. Obtain approval from Engineer for each run of raceway 1” or larger.

d. Do not run raceways through cast-in-place support elements without approval from the structural engineer.
e. Do not install raceways in topping slabs of 3" or less.
f. Locate raceways to avoid conflict with equipment, door bucks, partitions and other equipment bolted to floor.
g. Use concrete tight set screw conduit connectors.
h. Arrange stub-ups so curved portions of bends are not visible above finished slab. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; use flexible metal conduit 6" above the floor. Install threaded plugs flush with floor for future equipment connections.
i. Change from nonmetallic raceway to RMC or IMC before rising above floor.

10. Cut raceways square using saw or pipecutter.
11. Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 1", unless sweep elbows required. Bend raceways according to manufacturer's recommendations. Do not use torches or open flame to aid in bend of PVC conduit.
12. Use raceway fittings compatible with raceways and suitable for use and environment.
13. Provide bushings on all raceways.
14. Raceways minimum sizes:
    a. Minimum raceway size 3/4".
    b. Minimum size for flexible metal conduit is 1/2" for undercabinet luminaires.
        1) Exception: Minimum size for flexible connection on individual factory wired luminaires is 3/8"
    c. Minimum size for liquidtight flexible metal conduit is 3/4".
15. Install empty raceways with 200 lb nylon pull cord; leave at least 12" of slack at each end of pull wire. Cap raceways at both ends.
16. Feed devices on same wall vertically from above or junction box in suspended ceiling.
    a. Boxes may be fed from adjacent boxes with conduit entering bottom of each box such that future boxes may be placed without conduit adjustment.
    b. Do not install horizontal bends in conduit around corners.
17. Raceways Supports:
    a. Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
    b. Raceway supports for horizontal or vertical single runs:
        1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
    c. Raceway supports for horizontal and vertical multiple runs:
        1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
        2) Support horizontal runs with appropriately sized rods.
        3) Anchor vertical runs to structure.
    d. Vertical raceway runs 1-1/4" and larger passing through floors: Support at each floor with pipe riser clamps.
    e. Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.

f. Secure raceways in metal stud walls to prevent rattling.
g. Arrange raceway supports to prevent misalignment during wiring installation.
h. Do not fasten raceways to corrugated metal roof deck.
i. For fasteners and supports, including steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 26 0529 – Hangers and Supports for Electrical Systems and NFPA 70.

18. Identify raceways per requirements in Section 26 0553 – Electrical Systems Identification.
19. Ground raceways per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
20. Flexible Conduit Connections: Use maximum of 72” of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
    a. Use LFMC in damp or wet locations subject to severe physical damage.
    b. Do not use LFMC in plenum spaces or within air handling equipment.
    c. Use FMC in dry locations not subject to severe physical damage.
21. Install PVC-coated raceways in areas with corrosive atmosphere as noted on plans.
22. Install stainless steel raceway clamps, mounting hardware, supports, hangers, etc., when located in wet areas.
23. Power and Communications Raceways: Minimum 12” separation when run parallel, cross perpendicular.

B. Wireways:
1. Install in accordance with manufacturer’s instructions.
2. Use screws, clips and straps to fasten raceway channel to surfaces.
3. Mount plumb and level.
4. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
5. Supports: Per manufacturer’s recommendations.
6. Close ends of raceway channel and unused conduit openings.

C. Indoor Service Poles:
1. Install wiring devices and communications outlets of type, quantity and spacing as indicated on drawings.
2. Maintain ground continuity throughout entire pole length per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
3. Raceway receptacle faceplates shall be labeled with adhesive labels with 1/4” high lettering per requirements in Section 26 0553 – Electrical Systems Identification, at bottom of receptacle.
4. Neatly cut openings in ceiling panels. Install trim plate.

D. Boxes:
1. Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.
2. Install the appropriate cover on surface-mounted boxes:
    a. Raised device covers on 4 square and handy boxes.

b. Device covers that are square drawn or square cut on boxes in block.
c. Tile covers on boxes in tile.
d. Round drawn device covers on boxes in lath and plaster walls or dry wall only.
e. Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

3. Set outlet boxes parallel to construction and independently attached to same.
4. Do not install back-to-back and through-the-wall boxes. Install with minimum 6" horizontal separation between closest edges of the boxes. Install with minimum 24" separation in acoustic-rated walls and fire-rated walls.
5. Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.
6. Box Support:
   a. Mount boxes straight.
   b. Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.
   c. Install stud support one side, with short piece of stud, for up to 2 gang device boxes.
   d. Do not support boxes with tie-wire.
   e. For one and two gang box support, manufactured bracket supports shall be accepted alternate.
   f. Support boxes independently of raceways.
   g. Install adjustable steel channel fasteners for hung ceiling outlet box.
   h. Install stamped steel bridges to fasten flush-mounted outlet box between studs.
   i. Do not install boxes to ceiling support wires or piping systems.
7. Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.
8. Mount boxes in block walls at block joint nearest to indicated height.
9. 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.
10. When boxes are installed in fire-resistive walls and partitions, limit penetrations to 16 sq in per penetration and not to exceed a total of 100 sq in per 100 sq ft of wall area. Use FireBlok fire suppression gaskets or fire stop putty pads acceptable to the fire marshal.
11. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.
12. Install boxes to be permanently accessible.
13. Do not intermix conductors from more than one system in same junction box or pull box, unless shown or specifically authorized otherwise.
14. Adjust box location up to 10' prior to rough-in to accommodate intended purpose.
15. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726 – Wiring Devices.
16. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.

17. The drawings do not necessarily show every outlet, pull or junction box required. Add all required boxes as necessary.

E. Floor Boxes:
   1. Set floor boxes level and flush with finished floor surface.
   2. Install floor boxes and fittings to preserve fire-resistant rating of slabs and other elements, using materials and methods specified in Section 26 0593 – Electrical Systems Firestopping.

F. Expansion Fittings:
   1. Install raceway expansion and deflection fittings in all raceway runs embedded in or penetrating concrete where movement perpendicular to axis of the raceway may be encountered.
   2. Install raceway expansion fittings complete with bonding jumpers in raceway runs that cross expansion joints in structure and raceway runs mechanically attached to 2 separate structures.
   3. Install fitting(s) that provide expansion and contraction for at least 0.0004” per ft of length of straight run per °F of temperature change.
   4. 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.

G. Raceway Penetration Seals:
   1. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
   2. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.
   3. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Section 26 0593 – Electrical Systems Firestopping.
   4. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
   5. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1” annual clear space between pipe and sleeve for installing mechanical sleeve seals.
   6. Underground, Exterior-Wall Penetrations: Install cast-iron “wall pipes” for sleeves. Size sleeves to allow for 1” annual clear space between raceway and sleeve for installing mechanical sleeve seals.
   7. Sleeve-Seal Installation: Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
   8. Provide chrome- or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.
   9. Remove temporary sleeves, if used for form wall openings, prior to installation of permanent materials.

H. Raceway Sealing Fittings:

1. Install listed watertight seals to prevent the passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of the building, where raceway passes between areas of different temperatures such as into or out of cold rooms, freezers and air handling units, where raceway enters room which at any time is subject to low or high temperatures and where raceway enters a room which at any time is subject to internal air pressures above or below normal.
2. Install watertight seals in interior of all raceways passing through building roof, ground floor slab (when the raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on the end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank coverplate to match finish of adjacent plates or surfaces.
3. Seal raceways entering or passing through “hazardous (classified) areas” as defined in NFPA 70.

I. Sleeve Installation for Electrical Penetrations:
1. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0593 – Electrical Systems Firestopping.
2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies, unless openings compatible with firestop system used are fabricated during construction of floor or wall.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors 2” above finished floor level.
7. Size pipe sleeves to provide 1/2” annular clear space between sleeve and raceway, unless sleeve seal is to be installed.

3.4 APPLICATION

A. Raceway uses permitted and not permitted per NFPA 70 requirements and as described below.

B. Rigid Metal Conduit (RMC) permitted to be installed as follows:
1. Installations below grade and in or under concrete slabs
2. All locations except corrosive atmospheres
3. Hazardous locations
4. Locations requiring mechanical protection
5. Stub up through slabs
6. Damp or wet locations
a. Mechanical rooms and loading dock shall be considered damp location.

C. Intermediate Metallic Conduit (IMC) permitted to be installed as follows:
1. Installation below grade and in or under concrete slabs
2. All locations, except corrosive atmospheres
3. Hazardous locations
4. Locations requiring mechanical protection

5. Damp or wet locations
    a. Mechanical rooms and loading dock shall be considered damp location.

D. PVC Coated Conduit permitted to be installed as follows:
1. In corrosive atmospheres or as noted on plans
2. Underground direct bury or encased in concrete
3. In exterior environments needing additional protection
4. Use PVC coated elbows

E. Electrical Metallic Tubing (EMT) permitted to be installed as follows:
1. Dry locations only
2. Interior partitions
3. Above suspended ceilings
4. In concrete slabs (where specifically approved)
5. Conduit Bodies (LB) for sizes 1 ½" and larger. Prohibited for 1 ¼" or less (unless specifically approved by Owner).

F. Flexible Metal Conduit (FMC) permitted to be installed as follows:
1. Use flexible metal conduit not over 4 ft in length for final connections for:
    a. Final connections to recessed luminaires in lengths not to exceed 6 ft.

G. Liquid Tight Flexible Metal Conduit (LFMC) permitted to be installed as follows:
1. Use liquid tight flexible conduit, not over 6 ft in length, for final connections to:
    a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment) in wet locations.
    b. Instruments and control devices
    c. PVC coated LFMC is not allowed in environmental air plenum spaces or air handling equipment.

H. Rigid Nonmetallic Conduit (RNC) permitted to be installed as follows:
1. Direct burial, concrete encased
2. Direct burial, in sand fill on bottom and top
3. Corrosive atmospheres
4. Use steel elbow in concrete encased runs

I. One-half inch raceway permitted:
1. Between controller and its control or pilot device
2. Between lighting switch and nearest outlet for luminaire
3. Control wiring where mounted on equipment where conduit must follow contour of equipment
4. Protective and signal systems where noted
5. Where shown on plans

3.5 CONDUIT COLORS

A. Conduits shall be pre-painted in the following colors for the systems identified:
1. Life Safety Branch – Yellow

2. Critical Branch – Orange
3. Normal Branch – White
4. Equipment Branch – Silver
5. Fire Alarm System – Red
6. HVAC Controls – Green
7. Data/Communications – Blue
8. Access Control – Purple

B. Paint all conduit/wiremold/junction boxes to match surface, except in mechanical rooms.

3.6 RACEWAY WIRING METHODS

A. Underground: Install galvanized rigid steel conduit or thickwall nonmetallic conduit encased in concrete; threaded conduit fittings for steel; primed and solvent glue fittings for PVC.

B. In Slab: Install electrical metallic tubing; concrete tight set screw conduit fittings; install cast metal boxes.

C. Outdoor Locations, Above Grade: Install galvanized rigid steel conduit or intermediate metal conduit; threaded conduit fittings; install cast metal or nonmetallic outlet boxes with threaded hubs.

D. Wet and Damp Indoor Locations: Install galvanized rigid steel conduit or intermediate metal conduit; threaded conduit fittings; install cast metal or nonmetallic outlet, junction, and pull boxes with threaded hubs. Install flush mounting outlet boxes in finished areas.

E. Concealed and Exposed Dry Locations Not Subject to Damage: Install electrical metallic tubing; install sheet metal boxes; install flush mounting outlet boxes in finished areas.

F. Exposed Subject to Damage: Install galvanized rigid steel conduit or intermediate metal conduit; threaded conduit fittings; install cast metal boxes with threaded hubs. Open public spaces such as parking garages and common areas are considered subject to damage.

G. Hazardous Locations: Install galvanized rigid steel conduit; threaded conduit fittings; install cast metal boxes.

3.7 FIELD QUALITY CONTROL

A. Inspect raceway, boxes, indoor service poles, and wireways for physical damage, proper alignment, supports and seismic restraints, where applicable.

B. Replace any damaged component of the raceway system, or install new raceway system.

C. Inspect components, wiring, connections and grounding.

3.8 REPAINTING

A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner.

B. Repair damage to PVC or paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner.

3.9 ADJUSTING

A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.

B. Install knockout closures in unused openings in boxes.

C. Align adjacent wall-mounted outlet boxes for switches and similar devices.

D. Adjust outlet boxes to allow luminaires to be positioned as indicated on drawings.

3.10 CLEANING

A. Clean interior and exterior of boxes, wireways, and indoor poles to remove dust, debris and other material.

END OF SECTION

SECTION 26 0533.13

SURFACE RACEWAY SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0553 – Electrical Systems Identification

D. Section 26 2726 – Wiring Devices

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes surface metallic raceway system for branch circuits and other low-voltage wiring.

B. Surface raceway system shall consist of raceway bases, appropriate fittings, and device mounting plates necessary for a complete installation.

C. The lengths of the raceways shown on drawings are illustrative and diagrammatic only and are not accurate. Raceways shall be provided completely installed to match lengths of cabinets and shelving as indicated on drawings.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. NFPA 70 – National Electrical Code

C. UL 5 - Surface Metal Raceways and Fittings

1.5 SUBMITTALS

A. Product Data: Catalog cuts of components.

B. Shop Drawings:
   1. Complete layout, with locations of raceway components.
   2. Grounding, branch circuiting, and wiring including locations of service entrances.
   3. Receptacle types, manufacturers, and spacing.
   4. Receptacle labeling with proper voltage, phase, circuit and panelboard designations, as indicated on drawings.
   5. Communication faceplate types, manufacturers and labeling.

C. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Closeout Submittals:
   1. Project Record Documents
      a. Record actual locations of surface raceways with receptacle types, locations and circuits identified.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain surface raceways from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

B. Comply with manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metallic Raceways:
   1. Hubbell
   2. Wiremold, Division of Legrand

2.2 FABRICATION

A. UL 5

B. Fabrication:

1. **[Steel] [Aluminum] [Stainless Steel]**
2. Suitable for use in dry interior locations only.
3. Two-piece with base and snap-on cover
4. Base: **[single compartment] [two compartments with fixed dividers]** and cover plate, as indicated on drawings
5. Sizes:
   a. 2-7/8” wide by 1-7/8” deep
      1) Hubbell HBL3000 series
      2) Wiremold Series 3000
   b. 4-3/4” wide by 1-3/4” deep
      1) Hubbell HBL4750 series
      2) Wiremold Series 4000
   c. 4-3/4” wide by 3-9/16” deep
      1) Wiremold Series 6000
   d. 6-3/4” wide by 2-11/50
      1) Hubbell 6750 Series
6. Covers with cutouts for device plates as shown on drawings.
7. Device plates with flange to overlap joint of adjacent cover.

C. Material:
   1. Steel/Stainless Steel Raceways: Galvanized steel, minimum thickness 0.040”
   2. Aluminum Raceways: Alloy 6063-T6 extruded aluminum, minimum thickness 0.078”
   3. Fittings: Same material and metal thickness as linear raceway components.

D. Finish:
   1. Steel Raceway:
      a. Electrostatically painted
      b. Manufacturer’s standard **[gray] [ivory]** color.
   2. Aluminum Raceways:
      a. Satin anodized 0.004” thick.
   3. Fittings: Color to match linear raceway components.

E. Accessories:
   1. Fittings: Available as standard accessories, including external corner units, internal corner units, flat units, blank end units, internal and external elbows, coupling for joining raceway sections, and device mounting brackets and plates.
   2. Wire Clips: One for every 2 linear ft of indicated raceway configuration.
   3. Corner elbows and tee fittings, to maintain 2” cable bend radius that meets requirements for communications pathways and specifications for fiber optic, coaxial, and high-performance twisted-pair cabling.
   4. Device Mounting Brackets and Plates: Plastic device mounting brackets and trim plates allowing installation of indicated wiring devices, and communications outlets horizontally in raceways; trim cover sized to overlap device cut-out in raceway, concealing seams; finished to match linear raceway components; plastic compatible with UL 94; brackets and plates, to match raceway width, and with device mounting holes.

F. Communications Outlets and Accessories:
   1. Cabling Type: Per requirements in Section 27 1000 – Structured Cabling and Section 27 1500 – Communications Horizontal Cabling.
   2. Mounting faceplates and bezels: Faceplates configuration per requirements in Section 27 1000 Structured Cabling and Section 27 1500 – Communications Horizontal Cabling.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate cover plate openings with the wiring devices contained within.

B. Provide manufacturer's 'touch-up' paint kit.

C. Coordinate surface raceways installation with casework shop drawings to match lengths of cabinets and shelving.

D. Verify location of raceways with architectural interior elevation drawings.

3.2 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

A. Install in accordance with ANSI/NECA 1 and manufacturer's instructions.

B. Install flathead screws, clips and straps to fasten surface raceways to substrates, ensuring they are permanently and mechanically anchored. Double-sided adhesive is not acceptable. Mount plumb and level. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Install wiring devices and communications outlets of type, quantity and spacing as indicated on drawings.

D. Mount raceways on wall or casework parallel to or at right angles to structure and casework.

E. Feed raceways mounted on walls from a backbox through a wall box connector. Determine point of feed in field and complete wiring connections.

F. Install a chase nipple extension between outlet box on wall and raceway when raceway mounted to support channel for modular casework.

G. Maintain ground continuity throughout entire raceway length per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

H. Install appropriate backbox extension rings where raceway is mounted to steel slotted channel or by some other method, stood off from wall.

I. Raceway receptacle faceplates shall be labeled with adhesive labels in accordance with requirements in Section 26 0553 – Electrical Systems Identification, for 15A, 20A and 30A receptacles.

J. Reinforce each cover section for every 30A receptacle in raceway with two 4-40 Phillips counter-sunk steel screws attached to enclosure near top and bottom of receptacle.

K. Identify communication outlets per requirements in Section 27 0553 – Communications Systems Identification.

L. Raceway base shall be secured using screws. Securing with double-sided adhesive is not acceptable.

3.4 FIELD QUALITY CONTROL

A. Inspect surface raceways for physical damage and proper alignment.

B. Inspect components, wiring, connections, installation, and grounding.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 0543.10

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 - Grounding and Bonding for Electrical Systems

B. Section 26 0533 - Raceway and Boxes for Electrical Systems

C. Section 26 0543.13 - Excavation and Backfill

D. Section 26 0553 - Electrical Systems Identification

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes conduits, ducts, and duct accessories for direct buried and concrete encased for underground distribution for electrical power and communications.

B. The terms duct and duct bank, as used in this Section, are defined as follows:
   1. Duct: A single underground conduit, encased in concrete or direct buried.
   2. Duct Bank: Two or more ducts run together.

1.4 REFERENCE STANDARDS

A. ANSI C2 – National Electrical Safety Code

B. ANSI C80.1 – Rigid Steel Conduit-Zinc Coated (GRC)

C. ASTM F512 – Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduits and Fittings for Underground Installation

D. NEMA TC2 – Electrical Polyvinylchloride (PVC) Conduit

E. NEMA TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

F. NEMA TC6&8 – PVC Plastic Utilities Duct for Underground Installation

G. NEMA TC9 – Fittings for PVC Plastic Utility Duct for Underground Installation

H. NFPA 70 – National Electrical Code

I. UL 651 – Schedule 40 and 80 Rigid PVC Conduit

J. UL 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit

K. UL E53373 – Underground Fiber Reinforced Epoxy Conduit (FRE)

L. ULG – Electrical Rigid Metallic Conduit-Steel

1.5 SUBMITTALS

A. Product data for the following:
   1. Duct bank materials, including spacers and miscellaneous components
   2. Ducts and conduits and their accessories, including elbows, end bells, bushings, seals, bends, fittings, plugs, pull tape, and solvent cement
   3. Warning tape

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual routing of conduits and duct banks.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70
   2. Comply with ANSI C2
   3. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Deliver ducts to project site with end capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUITS

A. Size: As indicated on drawings

B. Type: As indicated in Section 26 0533 - Raceway and Boxes for Electrical Systems
   1. Where PVC raceways are allowed to be directly buried:
      a. Concrete encasement required where ducts pass under roadways and parking lots.
      b. Concrete encasement within 10’ of entering foundation wall or passing below or within structural elements.

2.2 NONMETALLIC DUCT ACCESSORIES

A. Duct Accessories:
   1. Duct Spacers: 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. Horizontal and vertical locking separation between ducts as shown on drawings.
   2. Plugs: Closure plugs or caps of same material as conduit at ends of unused sections.
   3. Pull Tape: Nylon pull tape with measurement markings in uniform lengths in each empty duct.

B. Grounding:
   1. Steel grounding bushings.

C. Warning Tape: Underground line warning tape specified in Section 26 0553 - Electrical Systems Identification.

D. Solvent Cement and Primer: Recommended by conduit manufacturer.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into terminations with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Adjust the depth of electrical utilities to avoid existing utilities with no change to contract price.

D. [Utility Coordination: When duct lines are being constructed for use by a utility serving the project, consult with them for duct size and quantity, minimum bending radii, maximum distance between pulling points, grounding details, termination arrangement, and other criteria.]

E. Duct Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

3.2 EXISTING UTILITIES

A. The existing utilities shown on contract drawings have been plotted from available records. No guarantee is made as to accuracy of locations indicated, and is shown for the benefit of Contractor.

B. Contact all serving utility companies and have them locate their lines prior to commencing work. Telephone local locating contractor 48 hours prior to commencing work. Coordinate with Owner all existing utility lines prior to commencing work.

C. Protect shown, visible and located utilities from damage. Promptly repair all active shown, visible and located utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.

D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

3.3 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Construction Manager no fewer than 5 days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

3.4 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. PVC 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. Do not use conduit that requires the use of couplings for straight runs. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings or rigid metal conduit.

C. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 5ft 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 Section 26 0533 - Raceway and Boxes for Electrical Systems.

D. Expansion Fittings: Provide suitable expansion fittings or other suitable means to compensate for expansion and contraction for raceways crossing expansion joints in structures or concrete slabs between two adjacent structures and between a duct bank and structure. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as

recommended by manufacturer and as required. Refer to structural drawings for location of expansion joints in structures.

E. Sealing: Provide watertight entrance sealing device where an underground conduit enters a structure through a concrete roof or membrane waterproofed wall or floor.

F. Fire Stops: Provide fire stop openings around electrical penetrations to maintain fire-resistance rating, where underground raceways penetrate fire-rated walls or floors.

G. Pulling Cord: Install 100 lb test nylon cord in ducts, including spares. Identify with tags at each end and at any intermediate pull point the origin and destination of each spare duct. Provide a removable permanent cap over each end of each spare duct.

H. Concrete Encased Ducts: Support ducts on duct spacers.
   1. Spacer Installation: Space spacers close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft of duct. Secure spacers to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6” between tiers. Tie entire assembly together using tie wires and reinforcing steel. Install base and intermediate spacers at every coupling point of each duct line for a separation horizontally and vertically per NEC.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer’s written recommendations, or use other specific measures to prevent expansion-contraction damage.
      b. Terminate each pour in a vertical plane if more than one pour is necessary, and install reinforcing rod dowels as shown on drawings.
   3. Pouring Concrete: Space concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces.
   4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing bars and ties without forming conductive or magnetic loops around ducts or duct groups. Size reinforcing bars and wire ties as indicated on drawings.
   5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms of materials and in a manner acceptable to Architect.
   6. Warning Tape: Bury warning tape approximately 12” above all concrete-encased ducts and duct banks. Align tape parallel to and on the centerline of duct bank. Provide an additional warning tape for each 12” increment of duct bank width over a nominal 36”.
   7. Place duct banks on an undisturbed soil base if possible. Where concrete encased duct bank is installed over an extensive area of disturbed earth such that within the periphery of a building, provide a separate concrete base under the duct bank to ensure stability of raceways during installation. Allow this base to set before duct bank is installed.

I. Direct Buried Duct Banks:
   1. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

2. Space spacers close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft of duct. Secure spacers to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6" between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 26 0543.13 - Excavation and Backfill.
4. Install backfill as specified in Section 26 0543.13 - Excavation and Backfill.
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4" over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 26 0543.13 - Excavation and Backfill.
6. Warning Tape: Bury warning tape approximately 12" above all concrete-encased ducts and duct banks. Align tape parallel to and on the centerline of duct bank. Provide an additional warning tape for each 12" increment of duct bank width over a nominal 36".

J. Stub-Ups:
1. Use manufactured rigid steel conduit elbows for *all elbows,* stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to PVC ducts with adapters designed for this purpose.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete pads, extend steel conduit horizontally a minimum of 5 ft from edge of equipment pad or foundation. Encase in concrete for concrete encased ducts. Install insulated grounding bushings on terminations at equipment.

K. Arrangement and Routing:
1. Arrange multiple duct runs substantially in accordance with details shown on drawings. Locate underground ducts where indicated on drawings and grade to the elevations shown on civil drawings.
2. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where duct runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Construction Manager for written instructions before further work is done.
3. Maintain a 12" minimum separation between ducts and other systems in parallel runs. Do not place ducts over valves or couplings in other piping systems. Refer conflicts with these requirements to the Construction Manager for written instructions before further work is done.

3.5 EARTHWORK

A. Excavation and Backfill: Comply with Section 26 0543.13 - Excavation and Backfill, do not use heavy-duty, hydraulic-operated compaction equipment.

3.6 CONCRETE

A. Concrete: 3000 psi, 28-day strength, complying with Division 03 – Concrete, where concrete encased.

3.7 GROUNDING

A. Ground underground ducts according to Section 26 0526 - Grounding and Bonding for Electrical Systems.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
   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% fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Preparation for pulling in conductors:
   1. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.
   2. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. Do not backfill underground direct buried and concrete encased ducts until the Engineer has inspected them. Notify Engineer 48 hr in advance of duct concrete pour, or backfill of direct buried ducts.

3.9 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.

END OF SECTION

SECTION 26 0543.13

EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0543.*10* - Underground Ducts and Raceways for Electrical Systems

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section lists methods and materials for trench excavation and backfill for electrical and communications conduits in duct banks. Refer to Section 26 0543.*10* – Underground Ducts and Raceways for Electrical Systems.

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

B. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.

C. Duct: A single underground conduit encased in concrete or direct buried.

D. Duct Bank: Two or more ducts run together.

E. Fill: Soil materials used to raise existing grades.

F. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of fill or backfill immediately below sub-base, drainage fill, or topsoil materials.

G. Utilities: On-site underground ducts and duct banks as well as underground services within buildings.

1.5 SUBMITTALS

A. Submit list of materials to be used for backfill.

1.6 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at project site to comply with requirements in Division 01 Section “Project Coordination.”

PART 2 - PRODUCTS

2.1 FILL MATERIAL

A. Type 1 Fill:
1. Material from excavation separated from materials, which do not compact by tamping and rolling. No stones larger than 3” and no building, organic, or corrosive or frozen materials and no lumps larger than 6”.

B. Type 2 Fill:
1. Sand or gravel materials with none larger than 2” and of that portion passing the #4 sieve less the 5% to pass #200 sieve.

C. Type 3 Fill:
1. Gravel of rounded to sub-angular shape, screened, which will pass 3/4” sieve and retained on #4 sieve.

D. Type 4 Fill:
1. Pit run rock or gravel with maximum stone size of 1”.

E. Type 5 Fill:
1. Pea gravel, screened, which will pass 3/8” sieve and retained on #4 sieve.

2.2 CRUSHED ROCK

A. Crushed Rock: 1-1/4” minus, unless smaller is required for bedding material.

2.3 SAND

A. Sand: Clean and washed building sand.

2.4 TOPSOIL

A. Topsoil: Equal in quality to that removed.

2.5 SOD

A. New Sod: Mature, densely rooted grass free of weeds and objectionable grasses.

2.6 PLANTS

A. Plants: Obtained from a commercial nursery and be similar to those replaced.

PART 3 - EXECUTION

3.1 PREPARATION

A. Establish grade lines and locations of roadways and sidewalks, grade beams, and pile caps. Provide necessary stakes and batter boards.

B. Verify elevations of existing utilities prior to excavation for new ducts.

C. Verify locations of vaults and manholes with civil drawings

D. Coordinate excavation and backfill with Section 31 2000 – Earth Moving.

3.2 EXCAVATION

A. Provide excavation for underground work, including ducts, vaults, manholes, handholes, pull boxes, unless otherwise shown or specified. Lay duct in open trench, except when Architect gives written permission for tunneling.

B. Excavate trench 24” wider than duct or duct bank dimensions and 3”below bottom of duct.

C. Include clearing, tree removal, grubbing, pavement removal, substructure removal such as walls, footings, and piers, and all incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing, and transportation. Coordinate excavation extending beyond construction limits with Construction Manager and Owner.

D. Do not provide blasting on this project without written permission of Architect and Owner.

E. Remove all excess excavation material from site, unless directed otherwise.

F. Over excavate 3” and fill with 3” of sand, where trench bottom is rock, or rocky, or contains debris larger than 1”, or material with sharp edges.

G. Perform all crossings of concrete or asphalt after surface material has been saw cut to required width and removed.

H. Conform to utility company requirements for excavation and vault installation in addition to contract document requirements where excavations are for installing utility company’s ducts and vaults.

3.3 ROCK EXCAVATION

A. Use mechanical methods to remove rock in trenches for underground ducts.

B. Refer to Geotechnical Report available from Architect/Engineer for data on rock.

C. Include rock excavation in the Bid, unless otherwise indicated.

3.4 INSTALLATION

A. Keep underground ducts to proper line and grade and sealed to prevent entrance of animals or foreign matter.

B. Provide bracing and sheet piling as necessary to support trenches. Comply with Local Regulations, applicable provisions of OSHA Regulations on trenching, or with provisions of “Manual of Accident Prevention in Construction” published by Associated General Contractors of America.

C. Do not lay duct in water.

D. Keep trench free from water until duct joint material has hardened and concrete encasement is in place.

E. Do not increase the contract cost due to presence of ground water in soil or necessity of sheet piling or bracing trenches. Adjust contract cost when sheet piling is left in place, on written order of Owner.

F. Do not remove sheet piling until trench is substantially backfilled. Cut off sheet piling left in place not less than 2 ft below new, finished grade.

G. Place underground ducts on 3" compacted bedding of sand. Shape bedding for clearance for joints and fittings, tamped in place and graded evenly to ensure uniform bearing for the full length of duct. Do not support duct by blocking, planking or mounding of bedding material.

H. Install lines passing under foundations with minimum of 3"clearance to concrete and ensure there is no disturbance of bearing soil.

3.5 BACKFILL

A. Backfill around ducts by hand to depth of 12" above top of duct with Type 5 fill in 6" layers. Compact backfill thoroughly with compactor of suitable weight or with approved mechanical tamper. Do not use flooding or jetting with water.

B. Place backfill from 12" above duct to elevation of subgrade in layers not exceeding 8" in depth with Type 3, 4 or 5 fill.

C. Conform excavation, duct laying, backfilling, grading and surfacing, as herein specified, when excavation occurs on public property or areas beyond the property line. Comply with additional requirements for public utility or other authorities. Check with each utility and incorporate cost of any additional requirements in base bid.

D. Backfill around vaults and handholes to be free of debris larger than 1-3/4" in all directions to 1 ft from vault.

E. Provide 6" of pea gravel or sand bedding for vaults and handholes larger than 3'-0" x 3'-0". For smaller handholes, provide 3" pea gravel or sand.

F. Other backfill shall be free of debris larger than 6" in diameter.

G. Place backfill material so as to obtain a minimum degree of compaction of 95% of maximum density at optimum moisture content. Moisten backfill material as required to obtain proper compaction.

H. Broken pavement, concrete, sod, roots, and debris shall not be used for backfill.

3.6 DEWATERING

A. Provide, operate, and maintain all pumps or other dewatering equipment required for control of water in trenches and excavations for electrical and communications site work during the entire construction period.

3.7 SHORING

A. Provide as required by trenching and excavating to secure site work. Comply with applicable safety regulations.

3.8 FINISHING

A. On completion of trenching and backfilling operations, restore grades to original elevation or to new sub-grade elevation.

B. Replace surfaces to existing conditions when trenching is through existing areas or beyond construction limits.

C. Use 6” of topsoil and sod to match existing elevations in landscaped areas or as otherwise approved by Landscape Architect.

3.9 SURFACE FINISHING

A. Refinish every disturbed surface to its original condition.

B. Replace planted materials not surviving 90 days after contract acceptance at Contractor’s own expense.

C. Return after 1 year and re-fill, compact and refinish settled areas to grade.

END OF SECTION

SECTION 26 0553

ELECTRICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0516 – Owner Furnished Equipment

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0533 – Raceways and Boxes for Electrical Systems

D. Section 26 0543.*10* – Underground Ducts and Raceways for Electrical Systems

E. Section 26 0923 – Lighting Control Devices

F. Section 26 2200 – Low-Voltage Transformers

G. Section 26 2300 – Low-Voltage Switchgear

H. Section 26 2313 – Paralleling Low-Voltage Switchgear

I. Section 26 2413 – Switchboards

J. Section 26 2416.13 – Lighting and Appliance Panelboards

K. Section 26 2416.16 – Distribution Panelboards

L. Section 26 2416.19 – Isolation Panelboards

M. Section 26 2500 – Enclosed Bus Assemblies

N. Section 26 2713 – Electrical Metering

O. Section 26 2726 – Wiring Devices

P. Section 26 2816 – Enclosed Switches and Circuit Breakers

Q. Section 26 2913 – Enclosed Controllers

R. Section 26 3213 – Diesel Engine Generators

S. Section 26 3623 – Automatic Transfer Switches

T. Section 28 3113 – Fire Detection and Alarm Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

A. Section includes the following:
   1. Identification for raceways
   2. Identification for conductors and communication and control cable
   3. Underground-line warning tape
   4. Warning labels and signs
   5. Instruction signs and posted drawings
   6. Equipment identification nameplates
   7. Wiring devices identification

B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.4 REFERENCE STANDARDS

A. ANSI A13.1 – Scheme for the Identification of Piping Systems

B. ANSI C2 – National Electrical Safety Code

C. ANSI Z535.4 1998 – National Standards for Product Safety Signs and Labels

D. 29 CFR – Labor, Part 1910 – Occupational Safety and Health Standards, Section 1910.145 – Specifications for Accident Prevention Signs and Tags

E. NFPA 70 – National Electrical Code

F. UL-510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

1.5 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Architect for approval indicating nameplate size, lettering size, color and actual nameplate information.

1.6 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with ANSI Z535.4-1998

C. Comply with NFPA 70.

D. Comply with 29 CFR 1910.145.

1.7 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION

A. Fire Alarm Conduit
1. Material: Refer to Section 26 0533 – Raceways and Boxes for Electrical Systems and Section 28 3113 – Fire Detection and Alarm Systems
2. Identification: Raceways are to be factory applied permanent red in color for entire length and circumference.
3. Junction box covers are to be factory or field applied permanent red paint.

B. Conduit and Raceway colors:
1. Refer to Section 26 05 33 – Raceways and Boxes for Electrical Systems.

C. Raceways and Armored Cable over 600V
1. Paint “DANGER HIGH VOLTAGE [12,470 VOLTS]” with permanent red paint on black background.
2. Paint is to be water and corrosion resistant for indoor and outdoor applications.
3. Letters are to be 2” high for 4-5” raceways, 1” high for 3” raceways.

D. Raceways 600V and under
1. Identify circuits on raceways upon leaving panel. Identify empty conduits as “SPARE”.
2. Identify raceways with black permanent marker.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend.

B. Lettered ID Marking Tape Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

C. Color-Coding Electrical Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1” to 2” wide.
1. UL-510 listed, self adhesive, vinyl electrical tape

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

B. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6” by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.
5. Black letters on yellow background.

2.4 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. Self-Adhesive Arc Flash Warning Labels: Industrial grade, made of durable polyester with over-laminate to withstand harsh environments (UV rays, scratches and most chemicals).
   1. Manufacturer: Seton or approved equal

D. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. Nominal size, 7” x 10”.

E. Metal-Backed, Butyrate Warning Signs for Exterior Use: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with galvanized-steel backing; and with colors, legend, and size required for application. Nominal size, 10” x 14”.

F. 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.”
   3. Emergency System Warning: “WARNING – EMERGENCY SYSTEM – DO NOT LEAVE SWITCH IN THE “OFF” POSITION.”
   4. Automatic Start Warning: “WARNING – EQUIPMENT MAY START AT ANY TIME.”
   5. Arc Flash Labels: Per ANSI Z535.4 and NFPA 70 ART 110.16, the signal word WARNING appearing in black letters on an orange background, with second line below (Arc Flash and Shock Hazard) in black letters on white background and third line below (Appropriate PPE Required) in black letters on white background. Include the following information on the label:
      a. Equipment name
      b. Available bolted current
      c. Flash protection boundary distance
      d. Incident energy level at 18” expressed in cal/cm^2
      e. Personnel protective equipment (PPE) class
      f. Voltage shock hazard
      g. Limited shock approach boundary
      h. Restricted shock approach boundary
      i. Prohibited shock approach boundary

2.5 INSTRUCTION SIGNS AND POSTED DRAWINGS

A. Instruction Signs: Engraved, laminated acrylic or melamine plastic, minimum 1/16” thick for signs up to 20 sq in and 1/8” thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.

B. Posted Drawings: Print electrical riser diagrams on 20 lb bond paper. Reduce drawings to approximately 1/2 size. Contact Engineer to obtain updated original plans for printing.

2.6 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Indoor
   1. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Self adhesive backed. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8” unless noted otherwise.

B. Outdoor
   1. Engraved, Three-layer, Laminated UV Resistant Acrylic or Melamine Nameplate: Attached with non corrosive mechanical fastener or other permanent method to maintain compliance with NEMA rating of enclosure. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 1/2” unless noted otherwise.

2.7 WIRING DEVICES IDENTIFICATION

A. Refer to Section 26 2726 – Wiring Devices for requirements.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with “DANGER – HIGH VOLTAGE 12,470 VOLTS” in permanent paint red letters on black background at least 2” high on 4-5” conduit, 1” high letters on metal clad cable and 3” conduit. Repeat identification at 10 ft maximum intervals and at each termination.
   1. Identify covers of exposed junction and pull boxes with red paint. Stencil the legend “DANGER – HIGH VOLTAGE 12,470 VOLTS” in red letters 2” high.
   2. Print identification so it can be seen from all exposed sides of raceway and cable.

B. Junction Boxes and Pull Boxes: Identify Panel/Circuit of all conductors passing through box on junction box cover with black permanent marker.

C. Power-Circuit Conductor Identification: For conductors #8AWG and larger, use UL-510 vinyl color-coding conductor tape indicating voltage and phase. Smaller conductors are to utilize factory colored insulation only.

D. Branch Circuit Conductors: Identify conductor source and circuit number at load terminations, and junction boxes using cloth tape and permanent ink. Identify circuit number only at source termination using pre-printed wrap-around identification tape.

E. Equipment Grounding and Bonding Conductor Identification: For conductors #1/0 and larger, use green UL-510 vinyl conductor tape. Smaller conductors are to utilize factory colored insulation only.

F. Isolated Ground Conductor: All conductors are to have factory green insulation with yellow stripe. Field applied color coded tape identification is not allowed.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data 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 Operation and Maintenance Manual.

H. Locations of Underground Lines, Duct Banks, and Direct Buried Conduits and Conductors: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
      a. Automatic Transfer Switches
      b. Double Ended Equipment
      c. Generator Distribution Equipment
      d. Fire Pump Disconnects
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
   3. Arc Flash Warning Labels: install per NFPA 70E for each switchgear, switchboard, panelboard, motor control center, industrial control panel (every enclosure that may contain energized conductors or components). Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.
   4. Available Fault Current Labels: install per NFPA 70 for each piece of service entrance equipment. Locate labels so they are visible to the personnel before examination, adjustment, servicing or maintenance of the equipment.

J. Instruction Signs and Posted Drawings:
   1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend printed in all capital letters of 12 pt size minimum where instructions are needed for system or equipment operation.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8" high letters for emergency instructions at equipment used for bypass operations, load shedding, manual throw over, etc.

K. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates 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. Nameplate Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic self adhesive backed. Unless otherwise indicated, provide a single line of text with 3/8" high letters on 1-1/2" high nameplate; where 2 lines of text are required, use nameplates sized 2" high.
   b. Outdoor Equipment: Engraved, laminated UV resistant acrylic nameplates with 1/2" high letters. Outdoor equipment labels are to be factory applied with non-corrosive mechanical fasteners or other permanent method to maintain compliance with NEMA rating of enclosure.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
2. Install nameplates for equipment including, but not limited to, the following:
   a. Panelboards, electrical cabinets, and enclosures
   b. Access doors and panels for concealed electrical items
   c. Electrical switchgear and switchboards, including each device
   d. Transformers
   e. Electrical substations
   f. Emergency system boxes and enclosures
   g. Motor-control centers, including each device
   h. Disconnect switches
   i. Enclosed circuit breakers
   j. Motor controllers
   k. Pushbutton stations
   l. Automatic Transfer Switches
   m. Contactors
   n. Remote-controlled switches, dimmer modules, and control devices
   o. Battery inverter units
   p. Battery racks
   q. Power-generating units
   r. Voice and data cable terminal equipment
   s. Master clock and program equipment
   t. Intercommunication and call system master and staff stations
   u. Television/audio components, racks, and controls
   v. Fire alarm control panel and annunciators
   w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks
   x. Monitoring and control equipment
   y. Uninterruptible power supply equipment

z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions

aa. Non-concealed junction box covers of auxiliary electrical systems

L. Nameplates shall indicate equipment identification and shall be same as indicated on contract documents. Voltages shall be shown on panelboard nameplates.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach non-corrosive mechanical fasteners appropriate to the location and substrate. Attach in a method that does not compromise the NEMA rating of enclosure.

F. Posted Drawings and Operating Instructions: Mount drawings and operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment. Cover document with clear plexi-glass and aluminum frame. Mount frame to wall in a manner that will allow removal to update document.

G. Warning Signs: Install warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.

1. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed to convey the message; example: “DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED.”

H. System Identification Color Banding for Conductors: Each color band shall completely encircle conductor. Locate bands at source and load terminations and at all junction and tap boxes.

I. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.

1. Colors for 208/120 V Circuits:
   a. Phase A (left bus in panelboard): Black
   b. Phase B (center bus in panelboard): Red
   c. Phase C (right bus in panelboard): Blue
   d. Neutral: White with stripe to match corresponding phase conductor color
   e. Equipment Ground: Green
2. Colors for 480/277 V Circuits:
   a. Phase A (left bus in panelboard): Brown

b. Phase B (center bus in panelboard): Orange
c. Phase C (right bus in panelboard): Yellow
d. Neutral: Gray with stripe to match corresponding phase conductor color
e. Equipment Ground: Green

3. Colors for Isolation Panelboard branch circuit wiring:
   a. Isolated Conductor #1 – Orange with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor along entire length of conductor.
   b. Isolated Conductor #2 – Brown with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor along entire length of conductor

4. Field-applied, Color-Coding Conductor Tape: Apply no more than 2" wide using multiple turns. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings where possible.

J. Underground-Line Warning Tape: See Section 26 0543*.10* – Underground Ducts and Raceways for Electrical Systems for installation instructions.

K. Painted Identification: Prepare surface and apply paint according to paint manufacturer's instructions. Do not use cleaning solvents that will harm surface to be painted.

END OF SECTION

SECTION 26 0573

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0553 – Electrical Systems Identification

B. Section 26 0812 – Power Distribution Acceptance Tests

C. Section 26 0813 – Power Distribution Acceptance Test Tables

D. Section 26 1116 – Secondary Unit Substations

E. Section 26 1216 – Dry-Type, Medium-Voltage Transformers

F. Section 26 1316 – Medium-Voltage Fusible Interrupter Switchgear

G. Section 26 2200 – Low-Voltage Transformers

H. Section 26 2300 – Low-Voltage Switchgear

I. Section 26 2313 - Paralleling Low-Voltage Switchgear

J. Section 26 2413 – Switchboards

K. Section 26 2416.13 – Lighting and Appliance Panelboards

L. Section 26 2416.16 – Distribution Panelboards

M. Section 26 2416.19 – Isolation Panelboards

N. Section 26 2500 – Enclosed Bus Assemblies

O. Section 26 2550 – Generator Docking Station

P. Section 26 2813 – Fuses

Q. Section 26 2816 – Enclosed Switches and Circuit Breakers

R. Section 26 2913 – Enclosed Controllers

S. Section 26 3623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes computer based, fault current, arc flash, and overcurrent protective device coordination studies for an electrical distribution system, based on actual equipment supplied. Set protective devices based on results of the protective device coordination study.
   1. Coordination of series-rated devices is permitted only where indicated on drawings.

B. Furnish field information and data needed for the studies.

C. Available fault current and electrical equipment interrupting capacity indicated on drawings are based on the short circuit study performed during design as part of the construction documents.

D. Provide studies and reports prior to manufacture of the electrical distribution equipment.

E. Equipment submittal will not be approved until the coordination study is complete and the equipment submittals indicate compliance with the study recommendations.

1.4 REFERENCE STANDARDS

A. ANSI C57.12.10 – American National Standard for Transformers-230 kV and Below 833/958-8333/10 417 kVA, Single-Phase, and 750/862-60 000/80 000/100 000 kVA, Three-Phase, w/o Load Tap Changing; and 3750/4687-60 000/80 000 kVA with Load Tap Changing-Safety Requirements

B. ANSI C57.12.22 – American National Standard for Transformers-Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA & Smaller: High-Voltage, 34 500 GrdY/19 920 V & Below; Low Voltage, 480 V & Below-Requirements

C. ANSI C57.12.40 – American National Standard for Secondary Network Transformers-Subway and Vault Types (Liquid Immersed)-Requirements

D. ANSI C57.12.90 – General Requirements for Liquid-Immersed Distribution Power and Regulating Transformers

E. ANSI C57.96 – Distribution and Power Transformers, Guide for Loading Dry-Type (Appendix to ANSI C57.12 Standards)

F. IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants

G. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings

H. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

I. IEEE 399 – Recommended Practice for Power System Analysis

J. IEEE 620 – Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines

K. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

L. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

M. IEEE C37.010 – Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

N. IEEE C37.20.1 – IEEE Standard for Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear

O. IEEE 37.46 – American National Standard Specifications for Power Fuses and Fuse-Disconnecting Switches

P. IEEE C57.12 – General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers

Q. IEEE C57.96 – IEEE Guide for Loading Dry-Type Distribution and Power Transformers

R. ICEA P-32-382 – Short-Circuit Characteristics of Insulated Cable

S. ICEA P-45-482 – Short-Circuit Performance of Metallic Shielding and Sheaths of Insulated Cable

T. NEMA MG 1 – Motors and Generators

U. NFPA 70 – National Electrical Code (NEC)

V. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

W. NFPA 70C – Hazardous Locations Classification

X. NFPA 70E – Standard for Electrical Safety in Workplace

1.5 SUBMITTALS

A. Product Data: Computer software program to be used for studies. Include specific software version for owner record.

B. Product Certificates:
   1. Coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
   2. Arc flash calculations computer software programs, certifying compliance with IEEE 1584.

C. Qualification Data: For coordination study specialist.
   1. Submit qualifications of the organization proposed for performing the study. Include description of the equipment and computer-based computation methods or programs used and the names and experience histories of the personnel who will perform the study.

D. Other Action Submittals: Subsequent to having approval for system protective devices submit the following **[in digital format]**:
   1. Electrical one-line drawing drafted in computer software program with component names.
      a. Drawing minimum text height of 3/32”. Maximum paper size 30”x42”. Provide multiple drawing sheets as required.
   2. Fault current study report
   3. Equipment evaluation report

4. Coordination study input data, including completed computer program input data sheets
5. Coordination Study Report
6. Arc Flash Study and Report
7. Arc Flash labels
8. Serving utility information with utility letterhead, including but not limited to:
    a. Protective device part numbers/settings
    b. Maximum available 1P and 3P fault
    c. Line conductor sizes/lengths
    d. Transformer impedance
    e. Serving voltage
9. Provide copy of Owner's electrical safety program if site specific standards vary from instructions noted in this project specification. All software files, including report documents and system study native files (including relevant library files), to allow review and future use of files
10. Sample energized work permit form

1.6 QUALITY ASSURANCE

A. Perform studies using 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 organization 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. Perform study under the direct supervision and control of a Registered Professional Electrical Engineer licensed in the Commonwealth of Kentucky, with a minimum of 5 yrs recent experience in performing protective device coordination studies, arc flash calculations, and electrical system analysis. Final report shall be signed and sealed by said engineer.

C. Comply with IEEE 242 for short circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

B. Basis of Design Product:
    1. SKM Systems Analysis, Inc.
    2. CYME International, Inc.
    3. EDSA Micro Corporation
    4. ETAP

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399 and IEEE 1584.

B. Analytical features of fault current study computer software program shall include “mandatory,” “very desirable,” and “desirable” features as listed in IEEE 399 Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program reports device settings and ratings of all overcurrent protective devices and demonstrates selective coordination by computer-generated, time-current coordination plots.

D. Arc Flash Calculations: Software program capable of calculating Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices for coordination are indicated on drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Provide the study based on the actual electrical equipment supplied for the project.

3.2 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 power riser diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance(s).
   3. Power Riser Diagrams: 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. Generator kilovolt amperes, size, voltage, and source impedance
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length
         1). Prior to equipment purchase, utilize conservative lengths (up/down included) based on planned conduit routing to validate equipment ratings. Final study to utilize contractor provided as-built lengths to confirm equipment ratings.
      f. Busway ampacity and impedance

g. Motor horsepower and code letter designation according to NEMA MG 1
h. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment

4. Data sheets to supplement power riser diagrams, cross-referenced with tag numbers on diagrams, 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. Generator thermal-damage curve
   e. Ratings, types, and settings of utility company's overcurrent protective devices
   f. Special overcurrent protective device settings or types stipulated by utility company
   g. Time-current characteristic curves of devices indicated to be coordinated
   h. 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
   i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays
   j. Panelboards, switchboards, automatic transfer switch, switchgear, busways, ampacity, and interrupting rating in amperes rms symmetrical
      1). Automatic transfer switch withstand rating to comply with UL 1008. Equivalent trip curves are not accepted for specific breaker rated equipment – exact breaker and associated trip unit must be listed on UL certification.

3.3 FAULT CURRENT STUDY

A. Calculate maximum available short circuit current in amperes rms symmetrical at circuit breaker positions of electrical power distribution system. Provide calculation for a current immediately after initiation and for a three-phase bolted short circuit at the following:
   1. Switchgear and switchboard bus
   2. Medium-voltage controller
   3. Motor control center
   4. Distribution panelboard
   5. Branch circuit panelboard
   6. Disconnect switches
   7. Automatic transfer switch
   8. Manual transfer switch
   9. Equipment fed by Variable Frequency Drive (VFD)
   10. Industrial control panels including air handling equipment, elevator controllers, etc.

B. For standard non-bypass Pulse Width Modulation VFDs, a line short circuit condition may be ignored.

C. Verify mechanical equipment served meets or exceeds maximum short circuit available.

D. 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.
   1. Model the entire electrical distribution system from utility company point of connection to circuit breakers in 208 V distribution panels at secondary side of distribution transformers. Include mechanical HVAC equipment, motor driven equipment feeder circuits, and elevator feeder circuits.
   2. Model shall include components of the distribution system which would be exposed to fault current levels of 10,000 A symmetrical on a calculated basis.

E. Calculate momentary and interrupting duties on basis of maximum available fault current.

F. Perform calculations to verify interrupting ratings of overcurrent protective devices in compliance with IEEE 141, IEEE 241 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10
      b. ANSI C57.12.22
      c. ANSI C57.12.40
      d. IEEE C57.12.00
      e. IEEE C57.96
   2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1
   3. Low-Voltage Fuses: IEEE C37.46

G. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (5-cycle) fault currents on power riser diagrams in report. List other output values from computer analyses, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.

H. Equipment Evaluation Report:
   1. Prepare report on adequacy of overcurrent protective devices and conductors by comparing fault current ratings of devices with calculated fault current momentary and interrupting duties.
   2. For 600V overcurrent protective devices, ensure interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   3. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
   4. Verify adequacy of phase conductors at maximum 3-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure short circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   5. Notify Owner/Engineer promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution.

3.4 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 maximum and minimum 1/2-cycle short circuit currents.
   2. Calculate maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.
   3. Calculate maximum and minimum ground-fault currents.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 141, IEEE 241, IEEE 242 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:
   1. Devices non-operational 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. Protect transformers according to IEEE C57.12.00, for fault currents by device settings.

E. Protect motors served by voltages more than 600 V according to IEEE 620.

F. 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 equipment withstands the maximum short circuit current for a time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short circuit current. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Include voltage classes of equipment from utility's incoming line protective device down to and including each panelboard. The phase and ground overcurrent protection shall be included as well as settings for other adjustable protective devices.

H. Selective Coordination: Overcurrent devices installed upstream and downstream of automatic transfer switches and/or associated with NEC Article 700 Emergency and 701 Legally Required loads shall be selectively coordinated from source of supply (both normal and emergency sources) through final device. Change specific circuit breakers (type, frame, trip-unit, etc.) and equipment bus rating as necessary to meet this requirement. Selective coordination of the system indicated on the one-line diagram is based on Schneider, Caterpillar, and RussElectric equipment.
   1. Additionally, provide selective coordination for ground fault through-out.

I. Coordination Study Report: Prepare a written report indicating 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
f. Manufacturer and type of device
g. Range of adjustments and recommended settings

2. Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate adequate time separation exists between devices installed in series, drawn to show the boundaries of device operation on log-log scale graphs, including power utility company's upstream devices. Where time current curves do not explicitly illustrate selective coordination but breakers have been tested and documented as being selectively coordinated, submit manufacturer's literature to substantiate device coordination. Include on curve sheet a title and legend identifying portion of the system covered. 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, full-load amps, and damage curves
   g. Maximum fault current cutoff point
   h. Generator decrement curve and full-load amps
3. Plot characteristics where applicable:
   a. Medium- and low- voltage fuses including minimum melt, total clearing and damage bands
   b. Low-voltage circuit breaker trip devices
   c. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
   d. Ground-fault protective devices
   e. Motor starting characteristics and motor damage points
   f. Generator short circuit decrement curve and generator damage point
   g. Conductor damage curves
   h. Electric utility's protective devices
   i. Medium-voltage equipment relays
4. Zone-Selective Interlocking (ZSI): Where a switchboard or switchgear is equipped with zone-selective interlocking, provide both restrained and un-restrained settings for all main (source) and tie breakers that are part of the zone-interlocking scheme. Include both settings in tabular format and in coordination curves.
5. Energy-reducing maintenance switch: Where a circuit breaker is equipped with an energy reducing maintenance switch, provide both normal and "maintenance mode" settings for the breaker. Include both settings in tabular format and in coordination curves.
6. Notify Owner/Engineer promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution. Propose approaches to effectively protect

the underrated equipment. Present technical evaluation with discussion of logical compromises for best coordination.

J. Completed data sheets for setting of overcurrent protective devices.

K. Provide software file of completed study with closeout submittal.

3.5 ARC FLASH STUDY

A. Perform arc flash calculations for Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances. Utilize short circuit rating of equipment identified in fault current study – note infinite bus fault current alone is not acceptable.

B. Model worst-case arc flash conditions**,** including various operational configurations of the electrical system as described in Section 3.3.D.3.
   1. Equipment with PPE rating greater than 2 shall be investigated. Investigation shall include adjustment of upstream overcurrent device settings to determine if PPE rating can be reduced with minimal compromise to coordination with other overcurrent devices.
   2. Systems or portions thereof 240 V and less and on the secondary side of 112.5kVA or smaller transformer report calculated values from NFPA 70E equations.
   3. Study shall include investigation for “Maintenance Settings” scenario(s). Adjustable breakers shall be set to lowest instantaneous setting available
   4. Study shall include examination of DC arc-flash evaluation for [station-batteries.

C. Arc Flash Study Report: Provide study results in tabular form and include:
   1. Device or bus name
   2. Bolted fault and arcing fault current levels
   3. Arc Flash Incident Energy (AFIE) level at 455 mm expressed in cal/cm^2
   4. Flash protection boundary distances including:
      a. Limited shock approach boundary
      b. Restricted shock approach boundary
   5. Trip/Delay time
   6. Breaker opening time
   7. Working distance
   8. Equipment class and bus gap
   9. Personal protective equipment class (PPE)

D. Provide recommendation for reducing AFIE levels and enhancing worker safety.

3.6 FIELD QUALITY CONTROL

A. Inspect, set, test, and calibrate the protective relays, circuit breakers, fuses, and other applicable devices per requirements in Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables.

B. Upon final approval of study, provide weatherproof vinyl or polyester arc flash label for all electrical equipment defined above. Label shall include calculated flash protection boundary, incident energy in cal/cm^2 at working distance (mm working distance based on equipment class, per IEEE 1584), required PPE level, limited approach, restricted approach, equipment name,

company name/logo who performed the study, available fault current, overcurrent device settings if applicable, and date label was produced.

1. Label to comply with ANSI Z535. Use “WARNING” (ANSI safety orange background with an orange exclamation point safety symbol) for all arc flash levels.
2. Per NFPA 70E 130.5(C), due to use of incident energy analysis method, PPE categories shall not be provided on labels unless site specific standard PPE categories differ from incident energy levels noted in NFPA 70E Table 130.7(C)(16).
3. Include verbiage on label noting study should be re-examined once every (5) years or upon modifications to electrical system.

3.7 ADJUSTING

A. Make modifications to equipment, as required, to accomplish conformance with equipment evaluation study.

B. Adjust relay and overcurrent protective device settings according to recommended settings table provided by overcurrent protective device coordination study.

C. Verify maintenance mode indicators illuminate upon being engaged.

D. Notify Owner/Engineer in writing of any required major modifications.

3.8 INSTALLATION

A. Install PPE labels on each piece of equipment prior to energizing equipment.

B. PPE labels shall be protected by clear plastic cover, weatherproof type material, or laminated and mounted on front of equipment. Taping of PPE label to front of equipment is unacceptable.

C. PPE label shall be clearly visible upon approach to equipment.

D. For large pieces of equipment, label shall be placed near main overcurrent device or incoming feeder to equipment. For equipment such as switchboards, UPS, or switchgear, with multiple vertical sections, provide (1) label per vertical section.

E. Contractor to provide one-line diagrams (meet IEEE/ANSI standard 141), mounted on 24”x36” (minimum) Styrofoam backboard. These one-line diagrams shall be mounted in each electrical room.

F. Label shall be mounted at a minimum of 42 to bottom and maximum 66” to top above finished floor.

END OF SECTION

SECTION 26 0593

ELECTRICAL SYSTEMS FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0533 – Raceways and Boxes for Electrical Systems

B. See Architectural Specification sections for additional firestopping requirements.

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

A. Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions (walls, partitions, floors, and ceilings) including both empty openings and openings containing electrical penetrating items, including but not limited to raceways, cables, cable trays, busways, and wireways.

1.4 REFERENCE STANDARDS

A. ASTM E-814 – Standard Test Method for Fire Tests of Through-Penetration Firestops

B. UL 1479 - Fire Tests of Through-Penetration Firestops

C. UL 2079 - Tests For Fire Resistance of Building Joint Systems

1.5 PERFORMANCE REQUIREMENTS

A. Provide firestop system to resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Firestop systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.

C. Conform to applicable Code requirements of Authority Having Jurisdiction.

D. 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.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction and type of penetrating item. Include

firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetration items, including documentation of UL certification for firestop systems.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Material Safety Data Sheets provided with product delivered to job site.

E. Certification of compliance with Building Codes of Project location.

F. Inspection reports

1.7 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.

B. Firestopping tests shall be performed by a qualified testing and inspecting agency, or another agency performing testing and follow-up inspection services for firestop systems acceptable to Authorities Having Jurisdiction.

C. Manufacturer's representative shall be on-site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.

1.8 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, type and manufacturer, and UL Label where applicable.

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.

C. Handle in accordance with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.

1.9 PROJECT CONDITIONS

A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop systems' manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturers' written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 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 Owner's inspecting agency at least 7 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 building inspector, if required by Authorities Having Jurisdiction.

1.11 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

1.12 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M (Fire Protection Products Division), Hilti Inc, Tremco (Sealant/Weatherproofing Division), Nelson Firestop Products, Specified Technologies Inc, RectorSeal Corporation, approved equal.

B. Pyrophobic Systems, Ltd - Intumescent Technologies FireBlok fire suppression gasket for use in 4" X 4" X 2-1/8" boxes.

2.2 MATERIALS

A. Firestop Products: UL 1479, ASTM E-814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance; materials shall not contain flammable solvents.

B. Firestop Systems: Produced by the same manufacturer.

C. Fire Suppression Gaskets: Single piece gasket for use in 4" X 4" X 2-1/8" or smaller recessed electrical boxes in walls rated up to 2 hr.

D. Accessories: Components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Accessories include the following items:
   1. Permanent forming/damming/backing materials
   2. Temporary forming materials
   3. Substrate primers
   4. Collars
   5. Steel sleeves

E. Fill Materials: Including the following:
   1. Firestop putty, caulk sealant, intumescent wrap strips, intumescent firestop collars, firestop mortars, pillows/bags, or a combination of these products to provide a UL-listed system for each application required for this Project; mineral wool backing where specified in manufacturer's application detail.

F. Mixing
   1. 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

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean out openings immediately prior to installing through-penetration firestop system to comply with firestop system manufacturer's written instructions.

B. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

C. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

D. Install fire suppression gaskets inside electrical boxes before conductors are pulled. Install per manufacturer's requirements.

3.3 INSTALLATION

A. Comply with "System Performance Requirements" Article in Part 1 and with firestop system manufacturer's written installation instructions and drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during application as required. 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. Avoid multiple penetrations of common fire barrier opening. Seal each penetration in accordance with manufacturer's UL installation details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

D. Adhere fire suppression gaskets to inside, rear of electrical box with attached adhesive strips.

3.4 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. 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

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
   1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Provide certification by Installer that all through-penetration firestop systems have been firestopped in accordance with applicable Building Codes of Project location.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with specifications.

3.6 CLEANING

A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION

SECTION 26 0812

POWER DISTRIBUTION ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0513.16 – Medium-Voltage, Single- and Multi-Conductor Cables

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0526 – Grounding and Bonding for Electrical Systems

D. Section 26 0813 – Power Distribution Acceptance Test Tables

E. Section 26 2200 – Low-Voltage Transformers

F. Section 26 2300 – Low-Voltage Switchgear

G. Section 26 2313 – Paralleling Low-Voltage Switchgear

H. Section 26 2413 – Switchboards

I. Section 26 2500 – Enclosed Bus Assemblies

J. Section 26 2550 – Generator Docking Station

K. Section 26 2713 – Electrical Metering

L. Section 26 2816 – Enclosed Switches and Circuit Breakers

M. Section 26 2913 – Enclosed Controllers

N. Section 26 3213 – Diesel Engine Generators

O. Section 26 3623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes acceptance testing requirements for assessing the suitability for service and reliability of the power distribution system.

B. It is the purpose of this specification to assure all tested electrical equipment, both contractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

C. Tests and inspections shall be performed after installation.

D. Tests and inspections shall determine suitability for energization.

E. Electrical systems shall pass tests prior to substantial completion or Owner occupancy.

F. This specification requires contractor to engage services of NETA certified testing agency.

G. All tests tables referenced in this specification provided in Section 26 0813 – Power Distribution Acceptance Test Tables.

H. Items to be tested and inspected as follows:
1. 600-volt conductors and cables
2. Medium-Voltage conductors and cables
3. Medium Voltage Fusible Interrupter Switchgear
4. Electrical metering
5. Engine generator
6. Dry type transformers
7. Generator Paralleling Switchgear
8. Low-voltage switchgear
9. Switchboard
10. Low-voltage insulated-case/molded-case circuit breakers
11. Low-voltage disconnect switches
12. Automatic transfer switches
13. Motor control and motor control center
14. Metal-enclosed busways
15. Ground fault protection systems
16. Grounding systems
17. Thermographic survey

1.4 REFERENCE STANDARDS

A. ANSI/IEEE C2 – National Electrical Safety Code

B. ANSI/IEEE C37 – Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses

C. ANSI/IEEE C57 – Distribution, Power, and Regulating Transformers

D. ANSI/IEEE C62 – Surge Protection

E. ANSI/IEEE Std. 43 – IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery

F. ANSI/IEEE Std. 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

G. ANSI/IEEE Std. 141 – IEEE Recommended Practice for Electrical/Power Distribution for Industrial Plants (IEEE Red Book)

H. ANSI/IEEE Std. 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

I. ANSI/IEEE Std. 241 – IEEE Recommended Practice for Electrical Power Systems in Commercial Buildings (IEEE Gray Book)

J. ANSI/IEEE Std. 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

K. ANSI/IEEE Std. 399 – IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book)

L. ANSI/IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)

M. ANSI/IEEE Std. 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book)

N. ANSI/IEEE Std. 1100 – IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)

O. NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

P. NEMA AB 4 – Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications

Q. NEMA MG1 – Motors and Generators

R. NFPA 70 – National Electrical Code

S. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

T. NFPA 70E – Electrical Safety Requirements for Employee Workplaces

U. NFPA 101 – Life Safety Code

V. NFPA 110 – Emergency and Standby Power Systems

W. NIST – National Institute of Standards and Technology

X. OSHA – Part 1910 – Subpart S – 1910.308 – Special Systems

1.5 SUBMITTALS

A. Test Reports: Include the following:
   1. Summary of project
   2. Description of equipment tested
   3. Equipment used to conduct the test
   4. Description of test
   5. Test results, as compared to manufacturers' or industry accepted standards and tolerances
   6. Conclusions and recommendations

7. Signature of responsible test organization authority

B. List of equipment used to perform tests. Identify the following:
1. Type
2. Manufacturer
3. Model number
4. Serial number
5. Date of last calibration
6. Documentation of calibration leading to NIST standards

1.6 QUALITY ASSURANCE

A. Qualifications of Testing Agency:
1. Testing firm shall be a corporately and financially independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturer, supplier, and installers of equipment or system evaluated by the testing firm.
2. Testing firm shall be regularly engaged in testing of electrical equipment, devices, installations and systems.
3. Testing firm shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories.
4. On-site technical person shall be currently certified by the InterNational Electrical Testing Association in electrical power distribution system testing.
5. Testing firm shall use technicians who are regularly employed by the firm for testing services.
6. Testing firm shall submit proof of above qualifications with bid documents when requested.

PART 2 - PRODUCTS

2.1 Not applicable to this Section.

PART 3 - EXECUTION

3.1 PREPARATION

A. Documentation: Deliver the following to testing firm, minimum two weeks prior to commencement of testing:
1. Complete set of electrical plans and specifications, with available short circuit indicated on power riser diagrams.
2. Approved submittals and shop drawings of equipment being tested.
3. Pertinent change orders.
4. Evaluation, overcurrent protective device coordination and arc flash studies provided by Engineer.

B. Schedule: Notify Owner and Engineer 10 working days prior to performance of any tests.

C. Coordination: Coordinate with Construction Manager/Owner/Engineer the testing schedule and availability of equipment ready for testing.

D. Test Power: Provide test power (including specialized) for equipment testing before and after service energizing.

3.2 FIELD QUALITY CONTROL

A. Inspection and Test Procedures: Comply with NETA.

1. 600 V Conductors and Cables:

a. Visual and Mechanical Inspection:

1) Compare cable data with drawing and specifications.

2) Inspect exposed sections of cables for physical damage.

3) Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.

4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."

5) Inspect compression-applied connectors for correct cable match and indentation.

6) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.

7) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.

8) Inspect for correct identification and arrangements.

9) Inspect jacket and insulation condition.

b. Electrical Tests:

1) Perform insulation-resistance test using megohm meter. Applied potential to be 1000 VDC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.

2) Perform continuity tests to insure correct cable connection.

c. Test Values:

1) Insulation-resistance values should not be less than 50 megohms.

2. Medium-Voltage Cables:

a. Visual and Mechanical Inspection:

1) Compare cable date with drawings and specifications.

2) Inspect exposed sections of cables for physical damage.

3) Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.

4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."

5) Inspect compression-applied connectors for correct cable match and indentation.

6) Inspection for shield grounding, cable support, and termination.

7) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.

8) Inspect for adequate fireproofing in common cable areas, if specified.

9) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed and shields are correctly terminated for operation of protective devices.
10) Inspect jacket and insulation condition.
11) Inspect for correct identification and arrangements.

b. Electrical Tests:
1) Perform shield-continuity test on each power cable by ohmmeter method and record value.
2) Perform insulation-resistance test using megohm meter with voltage output of at least 2500 V. Individually test each conductor with other conductors and shields grounded. Test duration shall be 1 minute.
3) Perform DC high-potential test on cables, including terminations and joints after cable system installation and before placing cable in service. Adhere to precautions and limits as specified in applicable NEMA/ICEA Standards for the specific cable. Perform tests in accordance with ANSI/IEEE Standard 400. Test voltages shall not exceed 80% of cable manufacturer's factory test value or maximum test voltage in Table 6.
a) Ensure input voltage to test set is regulated.
b) Current-sensing circuits in test equipment shall measure only leakage current associated with cable under test and shall not include internal leakage of test equipment.
c) Record wet- and dry-bulb temperatures or relative humidity and temperature.
d) Test each section of cable individually.
e) Individually test each conductor with other conductors grounded. Ground shields.
f) Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable method as necessary.
g) Ensure maximum test voltage does not exceed limits for terminators specified in ANSI/IEEE Standard 48 or manufacturer's specifications.
h) Apply DC high-potential test in at least 5 equal increments until maximum test voltage is reached. No increment shall exceed voltage rating of the cable. Record DC leakage current at each step after constant stabilization time consistent with system charging current.
i) Raise conductor to specified maximum test voltage and hold for 15 minutes on shielded cable and 5 minutes on non-shielded cable. Record readings of leakage current at 30 seconds and one minute and at one-minute intervals thereafter.
j) Reduce conductor test potential to zero and measure residual voltage at discrete intervals.
k) Apply grounds for time period adequate to drain insulation stored charge.
l) When new cables are spliced into existing cables, DC high-potential test shall be performed on new cable prior to splicing in accordance with this section. After test results are approved for new cable and splice is complete, perform insulation-resistance test and shield-continuity test on the length of new and existing cable including the splice. After satisfactory insulation-resistance test, DC high-potential test shall be performed on cable using test voltage acceptable to Owner and not exceeding 60% of factory test value.

c. Test Values:
   1) Shielding must exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 ft of cable.
   2) Graphic plots may be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.
      a) Step voltage slope should be reasonably linear.
      b) Capacitive and absorption current should decrease continually until steady state leakage is approached.

3. Electrical Metering:
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Verify tightness of electrical connections.
      4) Inspect cover gasket, cover glass, condition of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
      5) Verify freedom of movement, correct travel and alignment, and tightness of mounting hardware.
   b. Electrical Tests:
      1) Check calibration of meters at cardinal points.
      2) Calibrate watt-hour meters according to manufacturer's published data.
      3) Verify instrument multipliers.
      4) Electrically confirm current transformer and voltage transformer secondary circuits are intact.

4. Engine Generator:
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect correct anchorage and grounding.
      4) Inspect air baffles, filter media, and cooling fans.
      5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
      6) Confirm correct application of manufacturer's recommended lubricants.
   b. Electrical and Mechanical Tests:
      1) Perform insulation-resistance test on generator winding with respect to ground in accordance with ANSI/IEEE Standard 43. Calculate polarization index.
      2) Test protective relay devices in accordance with paragraph "Protective Relays."
      3) Perform phase-rotation test to determine compatibility with load requirements.
      4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      5) Perform vibration baseline test. Plot amplitude versus frequency for each main bearing cap.
      6) Conduct performance test in accordance with NFPA Standard 110, Section 7-13 (Installation Acceptance).

7) Verify correct functioning of governor and regulator.
8) Verify function and temperature regulation for battery and engine heaters.

c. Test Values:
1) Polarization index values shall be in accordance with ANSI/IEEE Standard 43.
2) Vibration levels shall be in accordance with manufacturer's published data.
3) Performance tests shall conform to manufacturer's published data and NFPA 110.
4) Vibration amplitudes shall not exceed values shown in Table 10.
5) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

5. Dry Type Transformers:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that resilient mounts are free and that any shipping brackets have been removed.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
6) Perform thermographic survey of bolted electrical connections, in accordance with paragraph "Thermographic Survey."
7) Verify that as-lift tap connections are as specified.

b. Electrical Tests:
1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with Table 5. Calculate dielectric absorption ratio or polarization index.

c. Test Values:
1) Bolt-torque levels should be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation-resistance test values at one minute should be in accordance with Table 5.
3) The dielectric absorption or polarization index shall be greater than 1.0 and shall be recorded for future reference.

6. Low-Voltage Switchgear and Switchboard Assemblies:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Verify appropriate anchorage, required area clearances, grounding and correct alignment.
5) Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

6) Verify fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to circuit breaker's address for microprocessor-communication packages.

7) Verify that current and potential transformer ratios correspond to drawings.

8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench. Refer to manufacturer's published data or Table 12 for proper torque values.

9) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."

10) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

b) Make key exchange with devices operated in off-normal positions.

11) Inspect insulators for evidence of physical damage or contaminated surfaces.

12) Verify correct barrier and shutter installation and operation.

13) Exercise active components.

14) Inspect mechanical indicating devices for correct operation.

15) Verify filters are in place and/or vents are clear.

16) Perform visual and mechanical inspection of instrument transformers, in accordance with paragraph "Instrument Transformers."

17) Inspect control power transformers.

a) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

b) Verify that primary and secondary fuse ratings or circuit breakers match drawings.

c) Verify correct functioning of draw-out disconnecting and grounding contacts and interlocks.

b. Electrical Tests:

1) Perform tests on all instrument transformers in accordance with paragraph "Instrument Transformers."

2) Perform resistance tests through bus joints with low-resistance ohmmeter. Joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.

3) Perform insulation-resistance tests in each bus section, phase-to-phase and phase-to-ground for one minute in accordance with Table 1.

4) Perform over-potential test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. In the absence of any published data, Table 2 shall apply. Test voltage shall be applied for one minute.

5) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendation.

6) Perform current injection tests on the entire current circuit in each section of switchgear.

a) Perform current tests by primary injection, where possible, with magnitudes such that minimum of 1.0 amp flows in secondary circuit.
b) Where primary injection is impractical, utilize secondary injection with minimum current of 1.0 amp.
c) Test current at each device.

7) Determine accuracy of meters and calibrate watt-hour meters in accordance with paragraph “Electrical Metering.” Verify multipliers.
8) Perform phasing check on double-ended switchboard/switchgear to insure correct bus phasing from each source.
9) Perform the following tests on control power transformers:

a) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 1 unless otherwise specified by manufacturer.
b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
c) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
d) Verify correct function of control transfer relays located in switchboard/switchgear with multiple control power sources.

10) Potential Transformer Circuits:

a) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 1, unless otherwise specified by manufacturer.
b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage.
c) Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.

11) Verify operation of switchgear/switchboard space heaters.

c. Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare bus connection resistances to values of similar connections.
3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer’s published data. In the absence of manufacturer’s published data, use Table 1. Values of insulation resistance less than this table or manufacturer’s minimum should be investigated. Over-potential tests should not proceed until insulation-resistance levels are raised above minimum values.
4) Bus insulation shall withstand the over-potential test voltage applied.
5) Contact resistance values shall not exceed high limit of normal range as indicated in manufacturer’s published data. If manufacturer’s data is not available, investigate values that deviate from similar bus by more than 50% of lowest value.

7. Low-Voltage Insulated-Case/Molded-Case Circuit Breakers, 225A and Larger:

a. Visual and Mechanical Inspection:

1) Compare nameplate date with drawings and specifications.
2) Inspect circuit breaker for correct mounting.
3) Check cell fit, element alignment and racking mechanism for draw-out breakers.
4) Operate circuit breaker to insure smooth operation.
5) Inspect case for cracks or other defects.
6) Verify tightness of accessible bolted electrical connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
7) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests:
1) Perform a contact-resistance test.
2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.
3) Perform insulation-resistance test at 1000 VDC on all control wiring. Test duration shall be one minute. Do not perform the test on wiring connected to solid-state components. Follow manufacturer's recommendation.
4) Perform adjustments for final trip settings in accordance with overcurrent protective device coordination study.
5) Perform long-time delay time-current characteristic tests by passing 300% rated current through each pole separately, unless series testing is required to defeat ground fault functions.
6) Determine short-time pickup and delay by primary current injection.
7) Determine ground-fault pickup and time delay by primary current injection.
8) Determine instantaneous pickup current by primary injection using run-up or pulse method.
9) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
10) Verify trip unit calibrations by secondary injection.
11) Determine minimum operation voltage on shunt trip and close coils in accordance with Table 20.
12) Check charging mechanism.

c. Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare microhm or millivolt drop values to adjacent poles or similar breakers. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
3) Circuit breaker insulation-resistance shall be in accordance with Table 1.
4) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum shall be investigated.

5) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in Table 7. Circuit breakers exceeding specified trip time at 300% of pickup shall be tagged defective.

6) For molded-case circuit breakers, instantaneous pickup values shall be within manufacturer's published data or tolerances shown in Table 8.

7) Minimum operation voltages on shunt trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to Table 20.

8. Low-Voltage Disconnect Switches:

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.

2) Inspect physical and mechanical condition.

3) Inspect anchorage, alignment, grounding, and required clearances.

4) Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

5) Verify that fuse sizes and types are in accordance with drawings, short-circuit and overcurrent protective device coordination studies.

6) Verify that each fuse has adequate mechanical support and contact integrity.

7) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.

8) Perform thermographic survey of accessible bolted electrical connection in accordance with paragraph "Thermographic Survey."

9) Verify operation and sequencing of interlocking systems.

10) Verify correct phase barrier installation.

11) Verify correct operation of all indicating and control devices.

12) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests:

1) Measure contact resistance across each switchblade and fuseholder.

2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.

3) Measure fuse resistance.

4) Perform ground fault test, if applicable.

c. Test Values:

1) Compare bolted connection resistances to values of similar connections.

2) Bolt-torque levels should be in accordance with Table 12, unless otherwise specified by the manufacturer.

3) Compare microhm or millivolt drop values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.

4) Minimum insulation-resistance shall be in accordance with manufacturer's published data or Table 1.

5) Investigate fuse-resistance values that deviate from each other by more than 15%.

9. Automatic Transfer Switches:

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Verify manual transfer warnings are attached and visible.
5) Verify tightness of control connections.
6) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
7) Perform thermographic survey of accessible bolted electrical connections in accordance with paragraph "Thermographic Survey."
8) Perform manual transfer operation.
9) Verify positive mechanical interlocking between normal and alternative sources.
10) Inspect anchorage, alignment, grounding and required clearances.

b. Electrical Tests:

1) Measure contact resistance.
2) Perform insulation-resistance tests, phase-to-phase and phase-to-ground, with switch in both source positions. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendation.
3) Verify settings and operation of control devices.
4) Calibrate and set relays and timers in accordance with paragraph "Protective Relays."
5) Verify phase rotation, phasing and synchronized operation as required by the application.
6) Perform automatic transfer tests:
   a) Simulate loss of normal power.
   b) Return to normal power.
   c) Simulate loss of emergency power.
   d) Simulate all forms of single-phase conditions.
7) Verify correct operation and timing of following functions:
   a) Normal source voltage-sensing relays.
   b) Engine start sequence.
   c) Time delay upon transfer.
   d) Alternate source voltage-sensing relays.
   e) Automatic transfer operation.
   f) Interlocks and limit switch function.
   g) Time delay and retransfer upon normal power restoration.
   h) Engine cool down and shutdown feature.

c. Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

2) Insulation-resistance test voltage and minimum values shall be in accordance with Table 1.

3) Compare microhm values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.

10. Motor Control and Motor Control Center:

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with drawings and specifications.

2) Inspect physical and mechanical condition.

3) Inspect anchorage, alignment and grounding.

4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.

5) Verify controller mechanical operations. Inspect gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

6) Verify motor running protection installed and properly sized.

7) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests:

1) Perform resistance tests through all bus joints with low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.

2) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground with controller closed and across each open pole. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendations.

3) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.

4) Test motor protection devices in accordance with manufacturer's published data. In the absence of manufacturer's data, use paragraph "Protective Relays."

5) Test circuit breakers in accordance with paragraph "Low-Voltage Insulated-Case/Molded-Case Circuit Breakers."

6) Perform operational tests by initiating control devices.

c. Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

2) Compare bus connection resistances to values of similar connections.

3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation-

resistance less than this table or manufacturer's minimum should be investigated.

4) Motor protection parameters shall be in accordance with manufacturer's published data.

11. Metal Enclosed Busways:
    a. Visual and Mechanical Inspection:
        1) Compare equipment nameplate data with drawings and specifications.
        2) Inspect busway for physical damage and correct connection in accordance with single-line diagram.
        3) Inspect for appropriate bracing, suspension, alignment, and enclosure ground.
        4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
        5) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey".
        6) Confirm physical orientation in accordance with manufacturer's labels to insure adequate cooling.
        7) Examine outdoor busway for removal of "weep-hole" plugs, if applicable, and correct installation of joint shield.
    b. Electrical Tests:
        1) Measure insulation resistance of each busway, phase-to-phase and phase-to-ground for one minute, in accordance with Table 1.
        2) Perform over-potential test on each busway, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. Test voltage shall be applied for one minute. If manufacturer has recommendation for this test, it shall be in accordance with Table 17.
        3) Perform contact-resistance test on each connection point of non-insulated busway. On insulated busway, measure resistance of assembled busway section and compare values to adjacent phase.
        4) Perform phasing test on each busway tie section energized by separate sources. Tests must be performed from their permanent sources.
        5) Verify operation of busway space heaters.
    c. Test Values:
        1) Bus bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
        2) Insulation-resistance test voltages and resistance values shall be in accordance with manufacturer's specifications or Table 1. Minimum resistance values are for nominal megohms for 1000 ft. For busway runs over 1000 ft, convert the measured resistance value to the 1000 ft nominal value:
            a) R / 1000 ft = Measured Resistance x Length of Run/1000 ft
        3) Values of insulation-resistance less than Table 1 or manufacturer's minimum should be investigated. Over-potential tests should not proceed until insulation-resistance levels are raised above minimum values.
        4) Over-potential test voltages shall be applied in accordance with manufacturer's recommendations. Insulation shall withstand over-potential test voltage applied.
12. Ground Fault Protection Systems:

a. Visual and Mechanical Inspection:
   1) Compare equipment nameplate data with drawings and specifications.
   2) Visually inspect components for damage and errors in polarity or conductor routing:
      a) Verify ground connection is made ahead of neutral disconnect link and on line side of any ground fault sensor.
      b) Verify neutral sensors are connected with correct polarity on both primary and secondary.
      c) Verify all phase conductors and neutral pass through sensor in same direction for zero sequence systems.
      d) Verify grounding conductors do not pass through zero sequence sensors.
      e) Verify grounded conductor is solidly grounded.
   3) Verify tightness of accessible bolted electrical connections, including control circuits, by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
   4) Verify correct operation of self-test panel.
   5) Set pickup and time-delay settings in accordance with settings provided on drawings and in specifications. Record operation and test sequences as required by NFPA 70.
   6) Verify the control power transformer has adequate capacity for the system.

b. Electrical Tests:
   1) Measure system neutral-to-ground insulation resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after testing.
   2) Perform insulation-resistance test of control wiring at 1000 VDC for one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.
   3) Perform the following pickup tests using primary injection:
      a) Verify relay does not operate at 90% of pickup setting.
      b) Verify pickup is less than 125% of setting or 1200 amp, whichever is smaller.
   4) For summation type systems using phase-neutral current transformers, verify correct polarities by applying current to each phase-neutral current transformer pair. This test also applies to molded-case breakers using external neutral current transformer.
      a) Relay should operate when current direction is the same relative to polarity marks in the two current transformers.
      b) Relay should not operate when current direction is opposite relative to polarity marks in the two current transformers.
   5) Measure time delay of the relay at 150% or greater of pickup.
   6) Verify reduced voltage tripping capability: 55% for AC systems and 80% for DC systems.

c. Test Values:
   1) System neutral-to-ground insulation shall be minimum of one megohm.
   2) Insulation resistance values shall be in accordance with Table 1.
   3) Relay timing shall be in accordance with manufacturer's specifications but must also be no longer than one second at 3000 amp.

4) Bus bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

13. Grounding Systems:
    a. Visual and Mechanical Inspection:
        1) Verify ground system is in compliance with drawings, specifications, and NFPA 70.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage.
    b. Electrical Tests:
        1) Perform fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on the main grounding electrode or system.
        2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
        3) Make resistance measurements in dry weather not earlier than 48 hours after rainfall.
    c. Test Values:
        1) The resistance between the main grounding electrode and ground should be no greater than five ohms. (Reference ANSI/IEEE 142.) Investigate any values above five ohms and notify Engineer immediately for further instructions.
        2) Investigate point-to-point resistance values that exceed 0.5 ohm.
14. Thermographic Survey:
    a. Visual and Mechanical Inspection:
        1) Inspect physical, electrical, and mechanical conditions.
        2) Remove all necessary covers prior to thermographic inspection.
        3) Equipment to be inspected shall include all current-carrying devices. Provide report including the following:
            a) Discrepancies.
            b) Temperature difference between area of concern and reference area.
            c) Cause of temperature difference.
            d) Areas inspected. Identify inaccessible and unobservable areas and equipment.
            e) Identify load conditions at time of inspection.
            f) Provide photographs and thermogram of deficient area.
    b. Test Parameters:
        1) Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1°C at 30°C.
        2) Equipment shall detect emitted radiation and convert detected radiation to visual signal.
        3) Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Refer to NFPA 70B, Section 20.17 (Infrared Inspection).
    c. Test Results:

1) Temperature differences of 1°C to 3°C indicate possible deficiency and warrant investigation.
2) Temperature differences of 4°C to 15°C indicate deficiency; repair as time permits.
3) Temperature differences of 16°C and above indicate major deficiency; repair immediately.
4) Suggested actions based on temperature rise can be found in Table 18.

B. Test Reports:
1. Testing firm shall do the following:
a. Prepare test report, including description of equipment tested, description of test, test results, conclusions and recommendations, retesting results, list of test equipment used and calibration date.
b. Show test results in comparison to industry and manufacturer's values and tolerances.
c. Interpret test results in writing and give recommendations for acceptance or rejection upon consultation with Engineer and prior to energizing equipment.
d. Assure electrical equipment is operational and within industry and manufacturer's tolerances, and is installed in accordance with contract documents.
e. Assure suitability of energization.
f. Report to the Owner and Engineer any system, material, or workmanship that is found defective on the basis of acceptance tests.
g. Retest equipment when required.
h. Maintain written record of tests.
i. Utilize safety practices during the tests in accordance with:
1) Acceptable state and local safety operating procedures
2) Owner's safety practices
3) OSHA
4) NFPA 70E
j. Perform tests with apparatus de-energized and grounded, except where otherwise specifically required ungrounded by test procedures.
k. Assemble and certify final test report.
l. Provide 4 copies of complete test report.
m. Attach label to all tested equipment with indication of date tested and testing firm name.
2. Contractor shall do the following:
a. Investigate, replace, or repair any fault in material or in any part of the installation revealed by the tests.
b. Deliver one copy of each test report directly to Engineer within 30 days after completion of testing, unless directed otherwise. Insert a copy of each test report in the equipment operation and maintenance manuals.

C. Test Equipment:
1. Test Instrument Calibration:
a. Testing firm shall have calibration program that assures test instruments are maintained with rated accuracy.

b. Instruments shall be calibrated in accordance with the following frequency schedule:
    1) Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
    2) Laboratory instruments: 12 months
    3) Leased specialty equipment: 12 months where accuracy is guaranteed by lessor
c. Dated calibration labels shall be visible on test equipment.
d. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
e. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
f. Equipment used for field testing shall be more accurate than instrument being tested.
g. Calibrating standard applied to testing equipment shall be of higher accuracy than instrument tested.

END OF SECTION

SECTION 26 0813

POWER DISTRIBUTION ACCEPTANCE TEST TABLES

TABLE 1
Insulation Resistance Test Values
Electrical Apparatus And Systems

Voltage Rating	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance In Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
34,500 and above	15,000	100,000

See Table 14 for temperature correction factors.

TABLE 2
Switchgear Low-Frequency Withstand Test Voltages

Type of Switchgear	Rated kV	Maximum Test Voltage kV AC	DC
Low-Voltage Power Circuit Breaker Switchgear	.254	1.6	2.3
	.508	1.6	2.3
	.635	1.6	2.3
MC (Metal-Clad Switchgear)	4.76	14.0	20.0
	8.25	27.0	37.0
	15.0	27.0	37.0
	27.0	45.0	+
	38.0	60.0	+
SC (Station-Type Cubicle Switchgear)	15.5	37.0	+
	38.0	60.0	+
	72.5	*120*.0	+
MEI (Metal-Enclosed Interrupter Switchgear)	4.76	14.0	20.0
	8.25	19.0	27.0
	15.0	27.0	37.0
	15.5	37.0	52.0
	25.8	45.0	+
	38.0	60.0	+

Derived from ANSI/IEEE C37.20.2-1993, Paragraph 5.5, *Metal-Clad and Station-Type Cubicle Switchgear* and C37.20.3-1993, Paragraph 5.5, *Metal-Enclosed Interrupter Switchgear*, and includes 0.75 multiplier with fraction rounded down.

The column headed “DC, Maximum Test Voltage kV” is given as a reference only for those using DC tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for voltage rating of switchgear. The presence of this column in no way implies any requirement for a DC withstand test on AC equipment or that a DC withstand test represents an acceptable alternative to the low-frequency withstand tests specified in this specification, either for design tests, production tests, conformance tests, or field tests. When making DC tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Because of the variable voltage distribution encountered when making DC withstand tests, the manufacturer should be contacted for recommendations before applying DC withstand tests to the switchgear. Voltage transformers above 34.5kV should be disconnected when testing with DC. Refer to ANSI/IEEE C57-13-1993 (*IEEE Standard Requirements for Instrument Transformers*) paragraph 8.8.2.
+ Consult Manufacturer

TABLE 3
Recommended Dissipation Factor/Power Factor at 20°C
Liquid Filled Transformers, Regulators, and Reactors
Acceptance Test Values

Oil, Silicone, and Less-Flammable Hydrocarbon Maximum Value (Percent)	
New Power Transformers and Reactors	0.5%
New Distribution Transformers and Regulators	1.0%
Remanufactured Power Transformers and Reactors	1.0%
Remanufactured Distribution Transformers and Regulators	1.5%

TABLE 4
Insulating Fluid Limits

Table 4.1 **Test Limits for New Insulating Oil Received in New Equipment**		
Mineral Oil		
Test	**ASTM Method**	**# 69 kV and Below**
Dielectric breakdown, kV minimum	D877	30
Dielectric breakdown, kV minimum @ 1 mm(0.04”) gap	D1816	25
Dielectric breakdown, kV minimum @ 2 mm(0.08”) gap	D1816	45
Interfacial tension mN/m minimum	D971 or D2285	38
Neutralization number, mg KOH/g maximum	D974	0.015
Water content, (ppm) maximum	D1533	20
Power factor at 25°C, %	D924	0.05
Power factor at 100°C, %	D924	0.40
Color	D1500	1.0
Visual condition	D1524	Bright and clear

ANSI/IEEE C57.106-2002, *Guide for Acceptance and Maintenance of Insulating Oil in Equipment,* Tables 1, 2, and 3.

Table 4.2 **Test Limits for Silicone Insulating Liquid in New Transformers**		
Test	**ASTM Method**	**Acceptable Values**
Dielectric breakdown, kV minimum	D877	30
Visual	D2129	clear, free of particles
Water content, (ppm) maximum	D1533	50
Dissipation/power factor, 60 Hz, % max. @ 25°C	D924	0.1
Viscosity, cSt @ 25°C	D445	47.5 – 52.5
Fire point, °C, minimum	D92	340
Neutralization number, mg KOH/g max.	D974	0.01

ANSI/IEEE C57.111-1989 (R1995), *Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers,* Table 2.

TABLE 4 (CONT.)
Insulating Fluid Limits

Table 4.3
Typical Values for Less-Flammable Hydrocarbon Insulating Liquid Received in New Equipment

ASTM Method	Test	Results		
		Minimum		Maximum
D1816	Dielectric breakdown voltage for 2 mm(0.08") gap, kV	40	34.5 kV class and below	---
		60	Desirable	
D1816	Dielectric breakdown voltage for 1 mm(0.04") gap, kV	20	34.5 kV class and below	---
		30	Desirable	
D974	Neutralization number, mg KOH/g	----		0.03
D877	Dielectric breakdown voltage kV	30		----
D924	AC loss characteristic (dissipation factor), % 25°C 100°C	 ---- ----		 0.1 1
D1533B	Water content, (ppm)	----		25
D1524	Condition-visual	Clear		
D92	Flash point (°C)	275		----
D92	Fire point (°C)	300[a]		----
D971	Interfacial tension, mN/m, 25°C	38		----
D445	Kinematic viscosity, mm^2/s. (cSt), 40°C	1.0 X 10^2(100)		1.3 X 10^2(130)
D1500	Color	----		L2.5

ANSI/IEEE C57.121-1998, *IEEE Guide for Acceptance and Maintenance of Less-Flammable Hydrocarbon Fluid in Transformers,* Table 3.

The test limits shown in this table apply to less-flammable hydrocarbon fluids as a class. Specific typical values for each brand of fluid should be obtained from each fluid manufacturer.

a. If the purpose of the HMWH installation is to comply with the NFPA 70 *National Electrical Code*, this value is the minimum for compliance with NEC Article 450.23.

TABLE 5

Transformer Insulation-Resistance
Acceptance Test Voltage and Minimum Results

Transformer Coil Rating Type in Volts	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance in Megohms	
		Liquid Filled	Dry
0 - 600	1000	100	500
601 - 5000	2500	1000	5000
5001 - 15000	5000	5000	25000

See Table 14 for Temperature Correction Factors.
NOTE: Since insulation resistance depends on insulation rating (kV) and winding capacity (kVA), values obtained should be compared to manufacturer's test data.

TABLE 6
Medium-Voltage Cables
Acceptance Test Values

Table 6.1
DC Test Voltages

Rated Voltage Phase-to-Phase kV	Conductor Sizes AWG or kcmil (mm)	Nominal Insulation Thickness mils (mm)		Maximum DC Field Test Voltages, kV During/After Installation	
		100% Insulation Level	133% Insulation Level	100% Insulation Level	133% Insulation Level
5	8-1000 (8.4-507) Above 1000 (507)	90 (2.29) 140 (3.56)	115 (2.92) 140 (3.56)	28 28	36 36
8	6-1000 (13.3-507) Above 1000 (507)	115 (2.92) 175 (4.45)	140 (3.56) 175 (4.45)	36 36	44 44
15	2-1000 (33.6-507) Above 1000 (507)	175 (4.45) 220 (5.59)	220 (5.59) 220 (5.59)	56 56	64 64
25	1-2000 (42.4-1013)	260 (6.60)	320 (8.13)	80	96
28	1-2000 (42.4-1013)	280 (7.11)	345 (8.76)	84	100
35	1/0-2000 (53.5-1013)	345 (8.76)	420 (10.7)	100	124

Tables derived from ANSI/ICEA S-93-639/NEMA WC 74-2000, *5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy;* ANSI/ICEA S-94-649-2000, *Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts*; ANSI/ICEA S-97-682-2000, *Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts*; and The Okonite Company, *High-Voltage Proof Testing.*

The DC field test voltages listed above are intended for cable designed in accordance with ICEA specifications. When older cables or other types/classes of cables or accessories are connected to the system, voltages lower than those shown may be necessary. Consult the manufacturers of the cables and/or accessories before applying the test voltage.

TABLE 6 (CONT.)
Medium-Voltage Cables
Acceptance Test Values

Table 6.2
AC Test Voltages

Rated Voltage Phase-to-Phase kV	Conductor Sizes AWG or kcmil (mm)	Nominal Insulation Thickness mils (mm)		AC Test Voltage, kV	
		100% Insulation Level	133% Insulation Level	100% Insulation Level	133% Insulation Level
5 KV	8-1000 1001-3000	90 (2.29) 140 (3.56)	115 (2.92) 140 (3.56)	18 28	23 28
8 kV	6-1000 1001-3000	115 (2.92) 175 (4.45)	140 (3.56) 175 (4.45)	23 35	28 35
15 kV	2-1000 1001-3000	175 (4.45) 220 (5.59)	220 (5.59) 220 (5.59)	35 44	44 44
25 kV	1-3000	260 (6.60)	320 (8.13)	52	64
28 kV	1-3000	280 (7.11)	345 (8.76)	56	69
35 kV	1/0-3000	345 (8.76)	420 (10.7)	69	84

Tables derived from ANSI/ICEA S-93-639/NEMA WC 74-2000, *5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy;* ANSI/ICEA S-94-649-2000, *Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts*; ANSI/ICEA S-97-682-2000, *Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts.*

All AC voltages are RMS values.

TABLE 6 (CONT.)
Medium-Voltage Cables
Acceptance Test Values

Table 6.3 **Partial Discharge Requirements** **for Semiconducting Coating and Tape Designs Only**		
Rated Circuit Voltage Phase-to-Phase Volts	**Minimum Partial Discharge Extinction Level, kV**	
	100% Insulation Level	**133% Insulation Level**
2001-5000	4	5
5001-8000	6	8
8001-15000	11	15

ANSI/ICEA S-93-639/NEMA WC 74-2000, *5-56 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.*

Table 6.4 **Very Low Frequency Testing Levels** **0.1 Hz Test Voltage (RMS)**	
System Voltage Phase-to-Phase (kV) (RMS)	**Proof Phase-to-Ground (kV) (RMS)**
5	10
15	22
25	33
35	47

TABLE 7
Molded-Case Circuit Breakers
Values for Inverse Time Trip Test

(At 300% of Rated Continuous Current of Circuit Breaker)

Range of Rated Continuous Current Amperes	Maximum Trip Time in Seconds For Each Maximum Frame Rating[1]	
	250V	251 - 600V
0-30	50	70
31-50	80	100
51-100	140	160
101-150	200	250
151-225	230	275
226-400	300	350
401-600	----------	450
601-800	----------	500
801-1000	----------	600
1001-1200	----------	700
1201-1600	----------	775
1601-2000	----------	800
2001-2500	----------	850
2501-5000	----------	900

Reproduction of Table 5-3 from NEMA Standard AB4-1996.

[1] For integrally-fused circuit breakers, trip times may be substantially longer if tested with the fuses replaced by solid links (shorting bars).

TABLE 8
Instantaneous Trip Setting Tolerances for Field Testing of Marked Adjustable Trip Circuit Breakers

	Tolerances of High and Low Settings	
Ampere Rating	**High**	**Low**
Adjustable	+40%	-30%
Non-adjustable	+25%	-25%

Reproduction of Table 5-4 from NEMA publication AB4-1996.

For circuit breakers with nonadjustable instantaneous trips, tolerances apply to the manufacturer's published trip range, i.e., +40% on high side, -30% on low side.

TABLE 9
Instrument Transformer Dielectric Tests
Field Acceptance

Nominal System (kV)	BIL (kV)	Applied Potential Tests Field Test Voltage (kV)	
		AC	DC[1]
0.6	10	3	4
1.2	30	7.5	10
2.4	45	11.25	15
5.0	60	14.25	19
8.7	75	19.5	26
15	95	25.5	34
15	110	25.5	34
25	125	30	40
25	150	37.5	50
34.5	150	37.5	50
34.5	200	52.5	70

Derived from Paragraph 8.8.2 and Tables 2 and 7 of ANSI/IEEE C57.13-1993 (Standard Requirements for Instrument Transformers).

[1] DC potential tests are not recommended for transformers rated higher than 200 kV BIL. DC tests may prove beneficial as a reference for future testing. In such cases the test direct voltage should not exceed the original factory test RMS alternating voltages.

TABLE 10
Maximum Allowable Vibration Amplitude

RPM @ 60 Hz	Velocity in/s peak	Velocity mm/s	RPM @ 60 Hz	Velocity in/s peak	Velocity mm/s
3600	0.15	3.8	3000	0.15	3.8
1800	0.15	3.8	1500	0.15	3.8
1200	0.15	3.8	1000	0.13	3.3
900	0.12	3.0	750	0.10	2.5
720	0.09	2.3	600	0.08	2.0
600	0.08	2.0	500	0.07	1.7

Derived from NEMA publication MG 1-1998, Section 7.8.1, Table 7-1. Table is unfiltered vibration limits for resiliently mounted machines. For machines with rigid mounting, multiply the limiting values by 0.8.

TABLE 11
Overpotential Test Voltages for Electrical Apparatus Other than Inductive Equipment

Nominal System (Line) Voltage[1] (kV)	Insulation Class	AC Factory Test (kV)	Maximum Field Applied AC Test (kV)	Maximum Field Applied DC Test (kV)
1.2	1.2	10	6.0	8.5
2.4	2.5	15	9.0	12.7
4.8	5.0	19	11.4	16.1
8.3	8.7	26	15.6	22.1
14.4	15.0	34	20.4	28.8
18.0	18.0	40	4.0	33.9
25.0	25.0	50	30.0	42.4
34.5	35.0	70	42.0	59.4
46.0	46.0	95	57.0	80.6
69.0	69.0	140	84.0	118.8

[1] Intermediate voltage ratings are placed in the next higher insulation class.

TABLE 12

U.S. Standard
Bolt Torques for Bus Connections
Heat-Treated Steel – Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (psi)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

Bolt Torques for Bus Connections
Silicon Bronze Fasteners[1]
Torque (Foot Pounds)

Bolt Diameter in (Inches)	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

[1] Bronze alloy bolts shall have a minimum tensile strength of 70,000 psi.

TABLE 12 (CONT.)

Bolt Torques for Bus Connections
Aluminum Alloy Fasteners[2]
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

[2] Aluminum alloy bolts shall have a minimum tensile strength of 55,000 psi.

Bolt Torques for Bus Connections
Stainless Steel Fasteners[3]
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

[3] Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy.
Belleville washers: 302 alloy.

TABLE 13
SF_6 Gas Tests

Test	Method	Serviceability Limits[a]
Moisture	Hygrometer	Per manufacturer or 200 ppm[b]
SF_6 decomposition byproducts	ASTM D 2685	500 ppm
Air	ASTM D 2685	5000 ppm[c]
Dielectric breakdown Hemispherical contents	0.10” gap at atmospheric pressure	11.5 – 13.5 kV[d]

a. In the absence of consensus standards dealing with SF_6 gas tests, the NETA Standards Review Council suggests the above representative values.
b. According to some manufacturers.
c. Dominelli, N. and Wylie, L., *Analysis of SF_6 Gas as a Diagnostic Technique for GIS*, Electric Power Research Institute, Substation Equipment Diagnostics Conference IV, February 1996.
d. Per Even, F.E., and Mani, G. Sulfur Fluorides, Kirk, *Othmer Encyclopedia of Chemical Technology*, 4th ed., 11,428, 1994.

Reference: IEC 61634 High-Voltage Switchgear and Controlgear – *Use and Handling of Sulfur Hexafluoride (SF_6) in High-Voltage Switchgear and Controlgear.*

TABLE 14
Insulation Resistance Conversion Factors For
Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	°F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.25
30	86	1.98	1.58
35	95	2.80	2.00
40	104	3.95	2.50
45	113	5.60	3.15
50	122	7.85	3.98
55	131	11.20	5.00
60	140	15.85	6.30
65	149	22.40	7.90
70	158	31.75	10.00
75	167	44.70	12.60
80	176	63.50	15.80

TABLE 15 (not used)
High-Potential Test Voltage
Automatic Circuit Reclosers

Nominal Voltage Class, kV	Maximum Voltage, kV	Rated Impulse Withstand Voltage, kV	Maximum Field Test Voltage, kV, AC
14.4	15.0	95	35
14.4	15.5	110	50
24.9	27.0	150	60
34.5	38.0	150	70
46.0	48.3	250	105
69.0	72.5	350	160

Derived from ANSI/IEEE C37.61-1973(R1992), *Standard Guide for the Application, Operation, and Maintenance of Automatic Circuit Reclosers* and from C37.60-1981(R1992), *Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems.*

TABLE 16 (not used)
High-Potential Test Voltage
for Acceptance Test of Line Sectionalizers

Nominal Voltage Class, kV	Maximum Voltage, kV	Rated Impulse Withstand Voltage, kV	Maximum Field Test Voltage, kV, AC	DC 15 Minute Withstand (kV)
14.4 (1 ∅)	15.0	95	35	53
14.4 (1 ∅)	15.0	125	42	53
14.4 (3 ∅)	15.5	110	50	53
24.9 (1 ∅)	27.0	125	60	78
34.5 (3 ∅)	38.0	150	70	103

Derived from ANSI/IEEE C37.63-1984(R1990) Table 2 (*Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers of AC Systems*).

NOTE: Values of AC voltage given are dry test one-minute factory test values**.**

TABLE 17
Dielectric Withstand Test Voltages
Metal-Enclosed Bus

Type of Bus	Rated kV	Maximum Test Voltage, kV	
		AC	DC
Isolated Phase for Generator Leads	24.5	37.0	52.0
	29.5	45.0	--
	34.5	60.0	--
Isolated Phase for Other than Generator Leads	15.5	37.0	52.0
	25.8	45.0	--
	38.0	60.0	--
Nonsegregated Phase	0.635	1.6	2.3
	4.76	14.2	20.0
	15.0	27.0	37.0
	25.8	45.0	63.0
	38.0	60.0	--
Segregated Phase	15.5	37.0	52.0
	25.8	45.0	63.0
	38.0	60.0	--
DC Bus Duct	0.3	1.6	2.3
	0.8	2.7	3.9
	1.2	3.4	4.8
	1.6	4.0	5.7
	3.2	6.6	9.3

Derived from ANSI/IEEE C37.23-1987, Tables 3A, 3B, 3C, 3D, and paragraph 6.4.2. The table includes a 0.75 multiplier with fractions rounded down.

NOTE:

The presence of the column headed “DC” does not imply any requirement for a DC withstand test on AC equipment. This column is given as a reference only for those using DC tests and represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each class of bus.

Direct current withstand tests are recommended for flexible bus to avoid the loss of insulation life that may result from the dielectric heating that occurs with rated frequency withstand testing.

Because of the variable voltage distribution encountered when making DC withstand tests and variances in leakage currents associated with various insulation systems, the manufacturer should be consulted for recommendations before applying DC withstand tests to this equipment.

TABLE 18
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (TD) based on comparisons between similar components under similar loading	Temperature difference (TD) based upon comparisons between component and ambient air temperatures	Recommended action
1°C to 3°C	1°C to 10°C	Possible deficiency; warrants investigation
4°C to 15°C	11°C to 20°C	Indicates probably deficiency; repair as time permits
-- -- --	21°C to 40°C	Monitor until corrective measures can be accomplished
>15°C	>40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on)T. In the absence of consensus standards for TD, the values in this table will provide reasonable guidelines.

An alternative method of evaluation is the standards-based temperature rating system as discussed in Chapter 8.9.2, Conducting an IR Thermographic Inspection, *Electrical Power Systems Maintenance and Testing*, by Paul Gill, PE, 1998.

It is a necessary and valid requirement that the person performing the electrical inspection be thoroughly trained and experienced concerning the apparatus and systems being evaluated as well as knowledgeable of thermographic methodology.

TABLE 19
Overpotential Test Voltages
Electrical Apparatus Other than Inductive Equipment

Nominal System (Line) Voltage[a] (kV)	Insulation Class	AC Factory Test (kV)	Maximum Field Applied AC Test (kV)	Maximum Field Applied DC Test (kV)
1.2	1.2	10	6.0	8.5
2.4	2.5	15	9.0	12.7
4.8	5.0	19	11.4	16.1
8.3	8.7	26	15.6	22.1
14.4	15.0	34	20.4	28.8
18.0	18.0	40	24.0	33.9
25.0	25.0	50	30.0	42.4
34.5	35.0	70	42.0	59.4

a. Intermediate voltage ratings are placed in the next higher insulation class.

TABLE 20
Rated Control Voltages and their Ranges
for Circuit Breakers

The maximum voltage is measured at the point of user connection to the circuit breaker [see Notes (9) (10)] with no operating current flowing, and the minimum voltage is measured with maximum operating current flowing.

Rated Control Voltages and their Ranges for Circuit Breakers					
RATED CONTROL VOLTAGE (8)	**Direct Current Voltage Ranges (1)(2) Volts, DC**		**OPENING FUNCTIONS ALL TYPES**	**RATED CONTROL VOLTAGE (60 Hz)**	**ALTERNATING CURRENT (1)(2)(3)(5) CLOSING, TRIPPING, AND AUXILIARY FUNCTIONS**
	CLOSING AND AUXILIARY FUNCTIONS				
	INDOOR CIRCUIT BREAKERS	**OUTDOOR CIRCUIT BREAKERS**		**SINGLE PHASE**	**SINGLE PHASE**
24	---	---	14-28	120	104-127 (4)
48	38-56	36-56	28-56	240	208-254 (4)
125	100-140	90-140	70-140	Polyphase	Polyphase
250	200-280	180-280	140-280		180Y/104-
---	---	---	---	208Y/120	220Y/127
---	---	---	---	240	208-254

Derived from Table 8, ANSI C37.06-2000, *AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities.*

RATED CONTROL VOLTAGES AND THEIR RANGES FOR CIRCUIT BREAKERS Solenoid-Operated Devices	
RATED VOLTAGE	**Closing Voltage Ranges for Power Supply**
125 DC	90 – 115 or 105 – 130
250 DC	180 – 230 or 210 – 260
230 AC	190 – 230 or 210 - 260

Notes:

(1) Electrically operated motors, contactors, solenoids, valves, and the like need not carry a nameplate voltage rating that corresponds to the control voltage rating shown in the table as long as these components perform the intended duty cycle (usually intermittent) in the voltage range specified.

(2) Relays, motors, or other auxiliary equipment that function as a part of the control for a device shall be subject to the voltage limits imposed by this standard, whether mounted at the device or at a remote location.

(3) Includes supply for pump or compressor motors. Note that rated voltages for motors and their operating ranges are covered by ANSI/NEA MG-1-1978.

(4) Includes heater circuits.

(5) Voltage ranges apply to all closing and auxiliary devices when cold. Breakers using standard auxiliary relays for control functions may not comply at lower extremes of voltage ranges when relay coils are hot, as after repeated or continuous operation.

(6) Direct current control voltage sources, such as those derived from rectified alternating current, may contain sufficient inherent ripple to modify the operation of control devices to the extent that they may not function over the entire specified voltage ranges.

(7) This table also applies for circuit breakers in gas-insulation substation installations.

(8) In cases where other operational ratings are a function of the specific control voltage applied, tests in C37.09 may refer to the “Rated Control Voltage.” In these cases, tests shall be performed at the levels in this column.

(9) For an outdoor circuit breaker, the point of user connection to the circuit breaker is the secondary terminal block point at which the wires from the circuit breaker operating mechanism components are connected to the user’s control circuit wiring.

(10) For an indoor circuit breaker, the point of user connection to the circuit breaker is either the secondary disconnecting contact (where the control power is connected from the stationary housing to the removable circuit breaker), or the terminal block point in the housing nearest to the secondary disconnecting contact.

(11) Some solenoid operating mechanisms are not capable of satisfactory performance over the range of voltage specified in the standard; moreover, two ranges of voltage may be required for such mechanisms to achieve an acceptable standard of performance.

(12) The preferred method of obtaining the double range of closing voltage is by use of tapped coils. Otherwise, it will be necessary to designate one of the two closing voltage ranges listed above as representing the condition existing at the device location due to battery or lead voltage drop or control power transformer regulation. Also, caution should be exercised to ensure that the maximum voltage of the range used is not exceeded.

END OF SECTION

SECTION 26 1116

SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 - General Electrical Requirements

B. Section 26 0553 - Electrical System Identification

C. Section 26 0573 - Power System Studies

D. Section 26 0812 - Power Distribution Acceptance Tests

E. Section 26 0813 - Power Distribution Acceptance Test Tables

F. Section 26 0913 - Electrical Power Monitoring and Control

G. Section 26 1216 - Dry-Type, Medium-Voltage Transformers

H. Section 26 1316 - Medium-Voltage Fusible Interrupter Switchgear

I. Section 26 2300 - Low-Voltage Switchgear

J. Section 26 2413 - Switchboards

K. Section 26 2713 - Electrical Metering

L. Section 26 4300 - Surge Protective Devices

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF SYSTEM

A. Specification covers 3 phase secondary unit substations for operations at primary voltages of 601 V through 38 kV, and secondary voltages of 600 V or less.

B. This includes devices such as medium-voltage switchgear, transformers, low-voltage switchgear and metering compartments.

1.4 REFERENCE STANDARDS

A. NECA 1 - 2000 - Standard Practices for Good Workmanship in Electrical Contracting

B. NECA 400 - 1998 - Recommended Practice For Installing and Maintaining Switchboards

C. ANSI C37.121 - Switchgear - Unit Substations

D. UL 1062 - Unit Substations

1.5 SUBMITTALS

A. Submit shop Drawings for equipment provided under this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Schneider Electric; Square D
   2. ABB-GE Industrial Solutions
   3. Siemens

2.2 UNIT SUBSTATIONS

A. Unit substation shall be:
   1. Completely metal-enclosed assembly
   2. Constructed and assembled to permit lifting or rolling as single unit
   3. Arranged as indicated on drawings

B. Dimensions indicated on contract documents are maximum allowed.

C. Common bases and frame structure shall be 1-piece welded, structural steel.

D. Compartments shall be totally enclosed, stretcher leveled steel, not less than **2.657 mm(12 ga)**, bolted to base, with side, front and rear panels of 1-piece welded construction.

E. Compartments shall have ventilation louvers in top and bottom sections of front and rear panels.

F. Isolate cable compartments from bus compartments and leave ample space for cables or busways from above or below.

G. Phase bus material shall be copper.

H. Neutral bus material shall be copper.

I. Provide copper ground bus arranged for ground continuity between grounding bus, base, framework, and enclosing panels.

J. Neutral bus shall be same ampere capacity as phase buses.

2.3 PRIMARY INCOMING SECTION

A. Incoming section shall be medium voltage fusible switch in accordance with specification Section 26 1316 - Medium-Voltage Fusible Interrupter Switchgear.

2.4 TRANSFORMER SECTION

A. Transformer section shall be VPI dry type in accordance with specification Section 26 1216 - Dry-Type, Medium-Voltage Transformers.

2.5 LOW VOLTAGE SWITCHGEAR SECTION

A. Low voltage switchgear section shall be in accordance with specification Section 26 2300 - Low-Voltage Switchgear.

2.6 MULTIPLE SECTIONS

A. Section Assembly
   1. Sections shall be assembled at factory and tested by manufacturer.
   2. Sections and parts shall be match-mark to facilitate erection in field.

B. Cable and Bus Bar Connections
   1. Fusible Switchgear Section to Transformer Section
      a. Provide 15kV cable from load side of incoming section to transformer primary side.
         1). Cable size shall be 500kCMIL.
   2. Transformer Section to Low-Voltage Section
      a. Provide bus bar connection between transformer secondary side and Low Voltage Section.
         1). Bus bar shall be sized by manufacturer and is to be rated to meet the ampacity of 133% of transformer base rating for 40C ambient.

2.7 LABELING

A. Doors, hinged bolted panels, and screen doors giving access to high-voltage components or bus work shall be provided with "Danger - High Voltage" sign.

2.8 NAMEPLATE

A. Provide nameplates in accordance with Section 26 0553 - Electrical Systems Identification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate final locations of equipment with General Contractor, and review final locations with Architect/Engineer prior to setting equipment.

B. Protect equipment during installation to prevent twisting or deformations, exposure to potentially damaging environments, and work of other trades. Maintain protection until completion of construction.

3.2 ACCEPTANCE TESTING

A. Testing by Testing Agency

B. Testing shall be performed in accordance with Section 26 0812 – Power Distribution Acceptance Tests.

3.3 ADJUSTMENTS AND CLEANING

A. Immediately prior to final inspection, make final adjustments and thoroughly clean equipment. Refinish damaged enclosures to original quality.

END OF SECTION

SECTION 26 1216

DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 - General Electrical Requirements

B. Section 26 0553 - Electrical Systems Identification

C. Section 26 0812 - Power Distribution Acceptance Tests

D. Section 26 0813 - Power Distribution Acceptance Test Tables

E. Section 26 1116 - Secondary Unit Substations

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Specification covers dry type transformers, with primary voltage above 600 V, for unit sub station use. For use indoors.

1.4 REFERENCE STANDARDS

A. ANSI C57.12.50 - Requirements for Dry-Type Distribution Transformers, 1-500 kVA 1-phase and 15-500 kVA 3-phase, with high voltage 601 - 34,500 V, low voltage 120-1000 V

B. ANSI C57.12.51 - Dry-Type Power Transformers 501 kVA and Larger, 3-Phase with High-Voltage 601 to 34 500 V, Low-Voltage 208Y/120 to 4160 V, Requirements for Ventilated

C. ANSI C57.12.55 - Dry-Type Transformers in Unit Installations, Including Unit Substations - Conformance Standard

D. ANSI C57.12.70 - Terminal Markings and Connections for Distribution and Power Transformers

E. IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings

F. NEMA 5T20 - Dry Type Transformers for General Applications

G. UL 1561 - Dry Type General Purpose and Power Transformers

1.5 SUBMITTALS

A. Submit Shop Drawings for equipment provided under this Section.

B. Acoustical Sound and Vibration Test Data

1. Acoustical sound and vibration test data on manufactured unit.
   a. Test data sheets shall be submitted for review and approval by Owner and Architect/Engineer prior to shipment to job site.
   b. "Standard Test" data for like transformer design is not acceptable.
   c. Manufacturer shall provide 1 week advance notification of testing to Owner for opportunity for witnessing of testing.

C. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Square D -Schneider Electric
   2. ABB - General Electric
   3. Siemens
   4. Olsun Electrics
   5. Virginia Transformer

2.2 RATINGS

A. Ratings of transformer shall be as shown on drawings:
   1. Temperature Rise: 80C above ambient
   2. Primary: 12,470V – 95kV BIL
   3. Secondary: 480Y/277V – 30kV BIL
   4. Impedance: 5.75%

2.3 CONSTRUCTION

A. Transformer shall be cooled by natural air and forced air convection (AA/FA).
   1. Units shall include fans to increase kVA rating by 33%.
   2. Fan motors shall be 120 V with individual fusing.
   3. Dial type temperature gauge.
   4. Temperature monitor and fan control unit.
      a. Temperature monitor and fan control shall include:
         1). Digital readout.
         2). GREEN - power on, YELLOW - fan on, RED - high temperature indicating lights
         3). Audible high temperature alarm with alarm silence pushbutton
         4). Maximum temperature memory with read and reset switch
         5). Auto/manual fan control switch
         6). System test switch
         7). Auxiliary alarm contact for remote control and temperature monitoring

5. Temperature sensing in each coil.
6. Sequence of Operation
    a. Transformer operating below natural air convection cooling (AA) rating.
    b. GREEN light is activated
    c. Temperature rises to above natural air convection cooling (AA) rating
    d. Relay is energized, fans and YELLOW light activate.
    e. Temperature rises to higher set point, relay energizes and audible alarm, RED light, and circuit for remote alarms activates.
7. Control power shall be provided from internal control power transformer.

2.4 INSULATION TYPE VPI

A. Electrical Insulation
    1. Insulation system shall be rated 220°C.
    2. Temperature rise based on a 40°C ambient.
    3. Insulation shall be inorganic materials such as porcelain, glass fiber, electrical grade glass polyester, or Nomex.
    4. Coil assembly shall be Vacuum Pressure Impregnated (VPI) polyester.
    5. Transformer shall be:
        a. Designed for temperature rise of 80°C and shall be capable of operating at 33 % above base nameplate kVA capacity continuously.
        b. Designed to meet sound level standards for dry-type transformers.

2.5 CORE AND COIL

A. Coil
    1. Windings shall be 98% conductivity copper.

B. Core
    1. Constructed of high grade, grain oriented, non-aging silicon steel.

2.6 TAPS

A. Taps:
    1. +/- 2-1/2% taps with external handle for de-energized operation.
    2. Rigidly support
    3. Mark for connections
    4. Accessible from front or back by panel removal

2.7 ENCLOSURES

A. Transformer enclosure shall:
    1. Be constructed of 12 ga sheet steel.
    2. Be equipped with removable panels for access to core and coils.
    3. Include front and rear panels with ventilated grills.
    4. Include rubber isolation pads to isolate core from case. There shall be no metal-to-metal contact.

B. Finish
   1. Transformer enclosure and rails shall match switchgear color.

2.8 NAMEPLATE

A. Nameplates shall be:
   1. Secured to transformer enclosure with screws.

B. Transformer:
   1. Transformer shall have nameplate with:
      a. Manufacturer's name and drawing number.
      b. Electrical connection diagram
      c. Primary and secondary voltage rating
      d. kVA rating
      e. Basic Impulse Level

C. Doors:
   1. External doors and hinged bolted panels shall be provided with "Caution - High Voltage - Keep Out" signs.

D. Submit identification to Owner/Architect/Engineer for approval.

2.9 ACCESSORIES

A. Transformer shall include:
   1. Provisions for lifting and jacking
   2. Removable panel for access for de-energized tap changing
   3. Two ground pads.
   4. Threaded grounding lug.

PART 3 - EXECUTION

3.1 INSPECTION

A. Visually inspect equipment and components at time of delivery. Submit report to Owner/Architect/Engineer with list of items to be corrected.

3.2 INSTALLATION

A. Install equipment per manufacturer's recommendations and as indicated.

B. Coordinate final locations of equipment with Owner, and review final locations with Architect/Engineer prior to setting equipment.

C. Install transformer on concrete base on vibration isolation pads. Coordinate vibration mitigation requirements with project Structural Engineer.

D. Install transformer level and plumb.

3.3 FACTORY TESTING

A. The following standard factory tests shall be performed on equipment provided.
   1. Resistance measurements of windings and at the tap extremes of 1 unit only of a given rating on this project
   2. Ratio tests on the rated voltage connection and on all tap connections
   3. Polarity and phase-rotation tests
   4. No-load loss at rated voltage
   5. Excitation current at rated voltage
   6. Impedance and load loss at rated current and on the tap extremes of one unit only of a given rating on this project
   7. Applied potential test
   8. Induced potential tests
   9. Sound test
   10. Manufacturer shall provide copies of factory test reports to Engineer.

3.4 ACCEPTANCE TESTING

A. Testing by Testing Agency

B. Acceptance testing to be performed in accordance with Section 26 0812 - Power Distribution Acceptance Tests and Section 26 0813 - Power Distribution Acceptance Test Tables.

C. Equipment shall have passed applicable acceptance tests before energization.

D. Manufacturer's Field Service:
   1. Engage factory-authorized service representative to inspect and adjust field assembled components and equipment installation, including connections.
   2. Measure primary and secondary voltages and make appropriate tap adjustments.
   3. Provide 3 copies of manufacturer's representative's certification.

3.5 CLEANING OF TRANSFORMER

A. Clean transformer prior to initial testing and energization of unit, and again prior to final punch list.

B. Cleaning procedures shall be as follows:
   1. Vacuum surfaces of enclosure and transformer.
   2. Blow out components with dry compressed air.
   3. Use small paintbrush to dust small, hard to reach crevices.

END OF SECTION

SECTION 26 1316

MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0513.16 – Medium-Voltage, Single-and-Multi-Conductor Cables

C. Section 26 0553 – Electrical Systems Identification

D. Section 26 1116 – Secondary Unit Substations

1.2 REFERENCE

A. Work under this section is subject to requirements of the Contract Documents including the General Conditions of the Contract, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Provide medium voltage load interrupter switchgear consisting of 3 pole, 1 throw, dead front, metal enclosed, load interrupter switches, fuses and necessary accessory components, factory assembled and operationally checked.

1.4 REFERENCE STANDARDS

A. ANSI/IEEE C37.20.3 - Metal-Enclosed Interrupter Switchgear

B. ANSI/IEEE C37.20.4 - Indoor AC Medium-Voltage Switches used in Metal-Enclosed Switchgear

C. ANSI C37.57 - Metal-Enclosed Interrupter Switchgear Assemblies - Conformance Testing

D. ANSI/IEEE C62.11 (1999) - Metal Oxide Surge Arresters for AC Power Circuits (>1 kV)

E. NEMA SG5 - Power Switchgear Assemblies

F. NEMA SG6 - Power Switching Equipment

1.5 SUBMITTALS

A. Shop Drawings:
   1. Submit shop drawings for equipment provided under this Section.

B. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

1.6 QUALITY ASSURANCE

A. Obtain switchgear from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver switchgear individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:
   1. S&C
   2. Cutler-Hammer
   3. Square D – Schneider Electric
   4. Siemens

2.2 RATINGS (12,470V System)

A. Nominal System Voltage: 15 kV 3-phase, 3wire, grounded, 60 Hz

B. Maximum Design Voltage: 15 kV

C. Basic Impulse Level: 95kV

D. Main Bus Ampacity: 600A, continuous

E. Short Circuit Current Rating: 40kA, rms asym

F. Short-Time Current (Two Second): 25 kA, rms sym

G. Momentary Current: (10 Cycles): 40kA, rms asym

2.3 CONSTRUCTION

A. Enclosure
1. Provide NEMA 1 enclosure consisting of self-supporting floor-mounted equipment bays.
2. Each equipment bay shall be separately constructed cubicle.
3. Integrated switchgear assembly shall safely withstand effects of closing, carrying and interrupting currents up to maximum short circuit rating.
4. Enclosure, covers, doors shall be minimum 12 ga steel.
5. Provide a removable top cover and removable rear cover for each vertical section.
6. Provide a single full length, flanged front door equipped with 2 rotary latch type pad lockable handles for each vertical section.
7. Viewing window shall be installed to enable visual inspection of the disconnect blades through the closed door.

B. Bus
1. Phase buses shall be silver plated copper, rated 600 amperes.
2. Provide continuous silver plated copper ground bus through switchgear assembly. Connect bus to steel frame of vertical section
3. Size ground bus for rated (2-second) current of switchgear.
4. Drill main bus and ground bus for future extensions.
5. Cutout areas with removable covers for future extension of busses.

C. Load Interrupter Switch
1. Load interrupter switch:
a. Fixed mounted, manual 3-pole gang operated
b. Quick-make, quick-break over-toggle-type mechanism with speed of operation independent of operator
c. Separate main and break contacts
d. Insulating barriers between phases and between phases and enclosure
e. OPEN and CLOSED switch position indicators
f. Provisions for pad locking switch in open or closed positions.

D. Switch Operators
1. Isolate spring operator assembly from high voltage and couple through direct drive shaft.
2. Switch operating handle:

a. Permanently attached to front of switchgear
b. Covered by full height solid door for outdoor applications

2.4 FUSES

A. Current-Limiting type fuses
1. Fuse ampacity: as shown on drawings
2. Provide fuses rated for corresponding voltage class

2.5 SURGE ARRESTERS

A. Provide surge arrestors on all switches.

B. Surge arresters shall be rated to match the corresponding L-N voltage for each voltage class.

C. Provide fully shielded, dead front, metal-oxide, elbow type surge arrester with resistance-graded gap suitable for plugging into inserts.

D. Connect primary surge arrestors using manufacturer’s jumper cables.

2.6 WIRING TERMINATIONS

A. Provide wiring, terminal blocks and fuse blocks within vertical section as required.

B. Label control wiring with wire markers.

C. Provide wire termination system such that no additional cable bracing, tying or lashing is required to maintain short circuit withstanding rating of assembly.

D. Equip each cubicle section that contains lugs for incoming and/or outgoing feeders with horizontal cable supports.

E. Provide loop feed bus connections where indicated on drawings.

2.7 NAMEPLATE

A. Nameplates:
1. Engraved with 2” high black lettering on laminated plastic white background.
2. Secured to switchgear enclosure with screws.

B. Switchgear Assembly:
1. Provide nameplate indicating:
a. Manufacturer's name and drawing number
b. Voltage ratings (kV nominal; kV maximum design; kV BIL)
c. Main bus continuous rating (amperes)
d. Short circuit ratings (amperes, rms symmetrical and Mva 3-phase symmetrical at rated nominal voltage)
e. Monetary and fault-closing ratings (amperes, rms asymmetrical)
2. Provide nameplate in each bay indicating:
a. Ratings of interrupter switch (amperes continuous and interrupting)

b. Maximum rating of power fuse in amperes
c. Catalog number of fuse units or refill units

3. Mark control components for identification corresponding to designation on manufacturer's drawings.

2.8 ACCESSORIES

A. Control Power Transformer
1. Single phase
2. Primary disconnect fuse
3. 240/120 VAC secondary
4. Sized 200% of control power load

B. Provide key interlock system for interlocking multiple incoming switches on common bus.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Visually inspect to confirm that all items and accessories are in accordance with specifications and drawings.

B. Verify field measurements are as shown on shop drawings.

3.2 INSTALLATION

A. Install equipment per manufacturer's recommendations and as indicated.

B. Coordinate final locations of equipment with Owner and review final locations with Architect/Engineer prior to setting equipment.

C. Protect equipment during installation to prevent twisting or deformations, exposure to potentially damaging environments, and work of other trades. Maintain protection until completion of construction.

D. Verify tightness of accessible bolted bus joints with torque wrench prior to energizing switchgear. Tightness shall be in accordance with manufacturer's recommended values.

E. Conductor Bending
1. Bending of high-voltage cables should be avoided or minimized.
2. Necessary bends should meet minimum radii specified by cable manufacturer.

3.3 ACCEPTANCE TESTING

A. Testing by Testing Agency

B. Acceptance testing shall be performed in accordance with Section 26 0812 – Power Distribution Acceptance Tests.

C. Manufacturer's Field Service:

1. Engage factory-authorized service representative to inspect and adjust field assembled components and equipment installation, including connections.
2. Prior to energization, factory representative shall visually inspect switchgear installation to insure that switches and motor operators are operable and bus connections are complete.
3. Switch operators shall be tested minimum of 1 time after energization.
4. Measure primary and secondary voltages and make appropriate tap adjustments.
5. Provide 3 copies of manufacturer's representative's certification.

3.4 CLEANING

A. Switchgear shall be cleaned during construction phase, prior to initial testing and energization of unit, and prior to final punch-list.

3.5 TRAINING

A. Provide services of factory-trained representative to instruct Owner on maintenance and operation for period of 4 hours.

END OF SECTION

SECTION 26 2200

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 25 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0812 – Power Distribution Acceptance Tests

G. Section 26 0813 – Power Distribution Acceptance Test Tables

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes dry type distribution and buck-boost transformers rated 600V and less, with capacities up to 500 kVA.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. IEE C57.12.91 – Test Code for Dry Type Distribution and Power Transformers

C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

D. NEMA ST 1 – Specialty Transformers (except General Purpose Type)

E. NEMA ST 20 – Dry-Type Transformers for General Applications

F. NFPA 70 – National Electrical Code

G. UL 506 – Specialty Transformers

H. UL 1561 – Dry-Type General Purpose and Power Transformers

I. 10 CFR 431.192 – DOE Efficiency Standard for Distribution Transformers

1.5 SUBMITTALS

A. Product Data:
   1. Include rated nameplate data, capacities, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings:
   1. For each transformer size and type:
      a. Physical dimensions, including bolting templates, weight, and center of gravity
      b. Winding and termination material
      c. Loads, method of field assembly, components, and location and size of each field connection
      d. Wiring Diagrams: Power, signal, and control wiring
      e. kVA rating
      f. Primary taps
      g. Insulation class and temperature rise
      h. Efficiency values measured at 0, 25, 50, 75, and 100% load
      i. Impedance value – X/R and %Z
      j. Sound level
      k. “K” factor listing, where applicable

C. Submit 1/4” scale electrical room floor plans with transformer locations.

D. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Output Settings Report: Record output voltages and tap settings.

G. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of transformers.
   2. Operation and Maintenance Data:
      a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.
      c. Include in emergency, operation and maintenance manuals.
      d. Include manufacturer’s Seismic Qualification Certification, Installation Seismic Qualification Certification, manufacturer’s Ultra Quiet Transformers Sound Level Certification, where applicable, and Output Settings Report.

1.6 QUALITY ASSURANCE

A. Obtain transformers from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
   3. Comply with 10 CFR 431.192 for minimum efficiency standards.

C. Certifications:
   1. Furnish Engineer with manufacturer's Ultra Quiet Transformers Sound Level Certification, where applicable: Submit certification that ultra quiet transformers have sound level not exceeding 35 dB. Submit for each ultra quiet transformer. Include the following:
      a. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D – Schneider Electric

B. ABB – General Electric

C. Siemens

2.2 DISTRIBUTION TRANSFORMERS

A. Fabrication:
   1. NEMA ST 20, UL 1561
   2. Factory assembled and tested

3. Air-cooled, for 60 Hz service
4. Two winding dry type
5. Coils:
   a. Continuous wound construction and impregnated with non-hydroscopic, thermosetting varnish.
   b. Conductors: Continuous windings without splices, except for taps, and encapsulated wire resin compound to seal out moisture and air.
   c. Winding Materials: Copper
   d. Separate primary and secondary
   e. Internal Connections: Braised or pressure type
6. Cores: High-grade silicon steel, non-aging, with high magnetic permeability, low eddy current losses and low hysteresis. Magnetic flux densities below saturation point. Core laminations clamped with steel members, one leg per phase.
7. Rubber vibration absorbing mounts to isolate base of enclosure from core and coil assembly.
8. Transformer neutral visibly grounded to enclosures with flexible grounding conductor.

B. Enclosure:
1. NEMA 250
2. Type 2, unless otherwise indicated to comply with environmental conditions at installed location.
3. Code-gauge steel panel over core and coil.
4. Ventilated (air-cooled).
5. Cooling and terminal chamber access with both sides and rear obstructed.
6. Manufacturer’s lifting eyes or brackets.
7. Finish: Manufacturer’s standard gray enamel over prime coat after being degreased, cleaned, and phosphatized.

C. Ratings:
1. KVA Rating: 500 kVA maximum
2. Primary Voltage: As indicated on drawings.
3. Secondary Voltage: As indicated on drawings.
4. Insulation Class and Winding Temperature Rise:
   a. Transformers 15kVA and smaller: Class 220°C with 150°C temperature rise above 40°C ambient temperature.
   b. Transformers 25kVA – 112.5kVA: Class 220°C, with 115°C temperature rise above 40°C ambient temperature.
   c. Transformers above 112.5kVA: Class 220°C, with 80°C temperature rise above 40°C ambient temperature.
5. Top of Enclosure Temperature: Maximum 35°C above 40°C ambient temperature at warmest point at full load.
6. K-Factor Rating: UL 1561, as indicated on drawings.

D. Primary Taps:
1. Transformers rated less than 3kVA: None.
2. Transformers rated 3kVA - 15kVA: One 5% above and one 5% below normal full capacity.

3. Transformers rated 15kVA and larger: Two 2.5% above and two 2.5% below normal full capacity, minimum of four taps.

E. Energy Efficiency:
   1. Transformers rated 15kVA and larger, except K-rated, quiet type and ultra quiet type:
      a. 10 CFR 431.196 (a) (2) compliant

F. Sound Levels:
   1. NEMA ST 20, maximum average sound levels as follows:
      a. 45 dB for general-purpose transformer sizes less than 51kVA.
      b. 50 dB for general-purpose transformer sizes 51-150kVA.
      c. 55 dB for general-purpose transformer sizes 151-500kVA.

2.3 LUGS

A. Manufacturer's primary and secondary bolted lugs: labeled for 75°C copper and aluminum conductors for ventilated enclosures.

B. Connections at sides near bottom, accessible from front of cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Examine areas and surface to receive transformers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify space indicated for transformers' mounting meets code-required working clearances.

D. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

E. Verify that ground connections are in place and requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems have been met.

F. Purchase manufacturer's "touch-up" paint kit for repainting.

3.2 INSTALLATION

A. Install transformers in accordance with ANSI/NECA 1.

B. Install level and plumb within 1/2 degree, and at least 6" from the adjacent wall or structure to insure proper ventilation, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices.

C. Transformer mounting:
   1. Mount transformers as indicated on plans.
   2. Floor mounting:

a. Secure to floor via isolation pads between floor brackets (fabricated by manufacturer) and transformer.
b. Mount on vibration dampening laminated rubber/cork pad.

3. Wall mounting:
   a. Secure to concrete-and-block wall via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
   b. Secure to gypsum walls with independent steel slotted channel supports, secured to floor via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
   c. Mount on vibration dampening laminated rubber/cork pad.
4. Suspended mounting:
   a. Suspend transformer enclosures designed for floor mounting, where suspended from structural ceiling, via trapeze constructed of steel slotted channel support system hung via 1/2" minimum steel threaded hanger rods attached to structural members or inserts in structural slab. Each rod to contain spring isolator ceiling hanger. Use locking type nuts in assembly.
   b. Anchor and fasten transformers and their supports to building structural elements by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.

D. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to transformer using small, corrosion-resistant metal screws or rivets with methods and location not to violate the rating of the enclosure. Do not use contact adhesive.
   1. Indicate kVA rating, voltage/phase rating for primary and secondary.
   2. Identify source and load.

E. Connect each transformer to rigid conduit system with maximum 36" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

F. Install transformer in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

3.3 CONNECTIONS

A. Ground transformers according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.4 FIELD QUALITY CONTROL

A. Inspect transformers for physical damage, proper alignment, anchorage, grounding, connections, and installation.

B. Test transformers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Output Settings Report: Prepare a written report recording output voltages and tap settings and submit to Engineer.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 h of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10% and not being lower than nameplate voltage minus 3% at maximum load conditions.

3.7 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2300
LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

G. Section 26 2713 – Electrical Metering

H. Section 26 2813 – Fuses

I. Section 26 4300 – Surge Protective Devices

1.2 DESCRIPTION

A. Section includes free-standing, dead-front type, metal-enclosed, low-voltage distribution switchgear.

1.3 REFERENCE STANDARDS

A. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures

B. IEEE C37.20.1 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

C. IEEE C37.90 – Relay and Relay Systems Associated with Electric Power Apparatus

D. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

E. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

F. NFPA 70 – National Electrical Code

G. NEMA 2250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

H. UL 486A-486B – Wire Connectors

I. UL 869A – Reference Standard for Service Equipment

J. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

K. UL 1558 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.4 SUBMITTALS

A. Product Data: For switchgear, components and accessories indicated:
   1. Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of surge protective devices, switching and overcurrent protective devices.
   2. Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.

B. Shop Drawings:
   1. For switchgear specified in this Section:
      a. General Arrangement:
         1) Indicate front, plan, and side views of switchgear; access requirements; overall dimensions and components list; shipping splits and weights.
         2) Front elevation indicating location of devices and instruments.
         3) Sections through switchgear showing space available for conduits.
      b. Conduit entrance locations and requirements
      c. Nameplate legends
      d. Configuration, size and number of bus bars for each phase and current rating of buses
      e. Ground bus
      f. Neutral bus
      g. Short circuit ratings of switchgear and overcurrent protective devices, and bus withstand rating
      h. Instrument details; enclosure types and details
      i. Wiring diagrams: power, signal and control wiring
      j. Utility company's metering provisions with indication of approval by utility company
      k. Mimic-bus diagram; samples: representative portion of mimic bus with specified finish, for color selection
   2. Submit 1/4" scale floor plans with switchgear location and required clearances and service space around equipment.

C. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

F. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations, configurations, and ratings of switchgear and major components on single-line diagrams and plan layouts.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
      d. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Obtain switchgear from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver switchgear in 36" maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.
   2. Control-Power Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D – Schneider Electric

B. ABB – General Electric

C. Siemens

2.2 RATINGS

A. Nominal system voltage: 480Y/277V.

B. Main bus continuous amperes: As indicated on the drawings.

C. Short circuit current rating: As indicated on drawings.

D. Brace switchgear components to withstand mechanical forces for symmetrical fault current shown.

2.3 CONSTRUCTION

A. IEEE C37.20.1, UL 1558.

B. Free-standing, dead-front type; metal-enclosed; side, front and rear panels of one-piece welded or bolted construction; compartments with ventilation louvers in top and bottom sections of front and rear panels; supporting frame: steel channels rigidly fastened together, with same outside dimensions as the enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Incoming lug locations: bottom, as applicable per drawings.

E. Connection to the supply source by conduit and wiring. UL service entrance label.

F. Environmental Limitations:
   1. Ambient temperatures: not exceeding 40°C
   2. Altitude: Not exceeding 600 ft.

3. Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.

G. Device Mounting and Type:
1. Front and rear accessible switchgear: Front and rear aligned.
a. Main device and feeder devices: Drawout and compartmented power circuit breakers.

H. Bus:
1. Material: Copper with tin plating; copper: 98% conductivity.
2. Connections: Accessible from rear only for maintenance.
a. Bolted:
1) Not fewer than 4 bolts for each 4″ x 4″ contact
2) Not fewer than 2 bolts for each 2″ x 2″ contact
3) Grade 5 bolts and conical spring-type washers
3. Sizing: Standard size, based on 65°C over 40°C; full capacity of the breaker frame size, not the trip setting; fully rated vertical and horizontal bus sections.
4. Main Phase Buses: Three phase, 4 wire; uniform capacity for entire length of switchgear; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.
5. Bus Arrangement: A-B-C (left to right, top to bottom, front to rear).

I. Ground Bus: Extend length of switchgear.
1. 800 amp, hard-drawn copper of 98% conductivity, equipped with pressure connectors for feeder ground conductors.

J. Neutral Bus: 100% of the ampacity of phase buses, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

K. Hinged Front Doors: Allow access to metering, accessory, and blank compartments, with latch and padlocking provisions.

L. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchgear, with latch and padlocking provisions.

M. Circuit breaker compartment: Equipped to house drawout type circuit breakers, fitted with hinged outer doors, and segregated from adjacent compartments by steel barriers; equipped with drawout rails, levering out mechanism, primary and secondary contacts; The following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

N. Section barriers between main circuit breakers compartments: Extended to rear of section; rear compartment barrier between the cable compartment and the main bus; glass polyester barrier between adjacent vertical structures in the cable compartment.

O. Bus isolation barriers: Arranged to isolate line bus from load bus at each main circuit breaker; separate barriered compartment for current and potential transformers; main and riser buses fully isolated from breaker instrument and auxiliary compartments.

P. Bus bars connect: Between vertical sections and between compartments. Cable connections are not permitted.

Q. Safety shutter: To automatically cover line and load stubs to protect against accidental contact.

R. Provide a 4" diameter polymer lens infrared (IR) scanning window for each set of circuit breaker terminations, mounted on cable compartment door.

S. Metering Compartment: Fabricated compartment barriered from the rest of the section, with a hinged lockable front cover and removable bus links, complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchgear. Metering equipment: Provisions for mounting current transformers and potential transformers; meter base(s), metering conductors and miscellaneous appurtenances required by serving utility.

T. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchgear.
   1. Pull Section: Size as indicated on drawings, depth and height to match switchgear.

U. Pull Box on Top of Switchgear:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchgear.
   2. Removable top, front, and sides, same construction as switchgear.
   3. Insulating, fire-resistive bottom with separate holes for cable drops into switchgear.
   4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

V. Spare circuit breakers and spaces for future circuit breakers: Allowance in vertical section bus size.

W. Future Provisions: Fully equip spaces for future devices with bussing, bus connections, rails, mounting brackets, supports, and appurtenances, insulated and braced for short circuit currents, with continuous current rating of 800A. Extension of phase, neutral, and ground buses from both ends by means of predrilled bolt-holes and connecting links.

X. Adequate lifting means.

Y. Dimensions: 90" maximum height, excluding floor sills, lifting members and pull boxes; 84" depth; Length as required.

Z. Line and Load Terminations: Compression type, labeled for 75°C copper and aluminum conductors; suitable for number, sizes and trip ratings; feeder load terminals: tin-plated copper bus extensions equipped with pressure connectors for incoming and outgoing circuit conductors.

AA. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation, or fluidized epoxy coating. No live connections shall be accessible from the rear, except the breaker load side terminals.

1. Sprayed Insulation Thickness: 3 mils, minimum.
2. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
3. Breaker run-back customer cable terminations: Provide two-part, removable insulated boots to cover exposed buswork and cable lugs.

BB. Relays: IEEE C37.90; types and settings as indicated; with test blocks and plugs.

CC. Enclosure: Steel, NEMA 250, Type 1:

1. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
2. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.

DD. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchgear. Arrange in single-line diagram format showing bussing, connections and devices, using symbols and letter designations consistent with final mimic-bus diagram. Use black color plastic strips fastened flat against panel face with corrosion-resistant screws and rivets. Coordinate mimic-bus segments with devices in switchgear sections to which they are applied. Produce a concise visual presentation of principal switchgear components and connections. For double-ended switchgear provide blue mimic bus for the left side and red for the right side.

2.4 SERVICE ENTRANCE

A. UL 869A

B. Switchgear labeled as suitable for use as service entrance equipment, where applicable, with incoming line isolation barriers, and a removable neutral bond to switchgear ground for solidly grounded wye systems.

C. Bond Neutral bus to ground bus with removable jumper sized in accordance with NEC 250.66. Label jumper "Neutral-Ground Bonding Jumper - Do Not Remove Without Engineering Approval".

D. Surge arrestors on all phases per requirements in Section 26 4300 – Surge Protective Devices.

2.5 SHORT CIRCUIT CURRENT RATING

A. Switchgear with minimum short circuit current rating as indicated on drawings.

B. Switchgear: Marked with their maximum short circuit current rating at supply voltage.

C. Switchgear: Fully rated

2.6 SURGE PROTECTIVE DEVICES (SPD)

A. IEEE C62.41.1; integrally mounted, plug-in style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

B. Per requirements in Section 26 4300 – Surge Protective Devices.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Insulated Case Circuit Breaker and Accessories: ANSI C37.13, UL 1066:

1. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   a. Normal Closing Speed: Independent of both control and operator.
   b. Slow Closing Speed: Optional with operator for inspection and adjustment.
   c. Store-Energy Mechanism: Manually charged.
   d. Means for manual opening and closing.
   e. Operation counter.
3. Trip Devices: Electronic (solid-state, microprocessor-based), overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
   a. Functions: Long-time pickup and delay, short-time pickup and delay, ground-fault pickup and delay and instantaneous-trip functions, independent of each other in both action and adjustment.
   b. Temperature Compensation: Ensures accuracy and calibration stability from 23°F to 104°F.
   c. Field-adjustable time-current characteristics.
   d. Current Adjustability: Dial settings and ratings plugs on trip units or sensors on circuit breakers, or a combination of these methods.
   e. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
   f. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I^2t operation.
   g. Pickup Points: Five minimum, for instantaneous-trip functions.
   h. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
   i. Power measurement trip module with BACnet and Modbus communications protocol connection with the following features:
      1) True RMS sensing
      2) LCD Backlit display
      3) Display and communicate over Modbus and BACnet
         a) Power (Real and Apparent)
         b) Voltage (P-P, P-N)

c) Amperage per phase and neutral
d) Power factor

4. Auxiliary Contacts: For interlocking or remote indication of circuit breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit breaker operation. Each consists of two type "a" and two type "b" contacts wired through secondary disconnect devices to a terminal block in stationary housing; "a" contacts mimic circuit breaker contacts, "b" contacts operate in reverse of circuit breaker contacts.

~~4.~~a. *Provide interface with BAS system to enable remote viewing of Main and Tie breakers for each Switchgear lineup.*

5. Drawout Features: Circuit breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
   a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
   b. Circuit Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
      1) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
      2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
6. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
7. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
8. Operating Handle: One for each circuit breaker capable of manual operation.
9. Electric Close Button: One for each electrically operated circuit breaker.
10. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
11. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key interlock devices is indicated.
12. Shunt-Trip Devices: Where indicated.
13. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked wither with each other or with exterior devices.
14. Communication Capability: Integral communication module with functions and features compatible with power monitoring requirements.
15. Zone-Selective Interlocking: Where Indicated: Integral with electronic trip unit; for interlocking ground fault protection function, and/or short time function.

16. Control Voltage: 120VDC.
17. Listed for 100% of breaker's continuous ampere rating.

B. Ground Fault protection equipment on breakers, where indicated: Integrally mounted relay and trip unit, push-to-test feature and ground fault indicator:
   1. Ground-fault protection with at least three adjustable short-time-delay settings and three trip-time-delay bands; adjustable current pickup with maximum setting of 1200 A. Arrange to provide protection for the following:
      a. Four-wire circuit or system
   2. Trip units shall be capable of the following types of ground-fault protection: source ground return. Ground-fault sensing systems shall be field adjustable and replaceable.
   3. Neutral current transformers shall be provided for 4-wire system.
   4. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be in minimum three bands up to 1200 A.
   5. Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.

C. Arc Energy Reduction
   1. Where the highest continuous current trip setting for which the actual overcurrent device is rated or can be adjusted is 1200A or higher, an energy-reducing maintenance switch with local status indicator shall be provided.

2.8 ATO, CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

A. Control Circuits: 120V, supplied through secondary disconnecting devices from control-power transformer: Dry-type transformers in separate compartments for units larger than 3 KVA, including primary and secondary fuses. Provide dual control power supplies for double-ended switchboards. Control power connections to the bus are to be on the line side of the main disconnecting device for each incoming source.
   1. Provide AC-DC rectifier, DC Best Battery Selector and DC-DC converter as indicated in ATO Detail Diagram.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control components mounted within assembly, such as relays, pushbuttons, switches etc.: Suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

E. Control Wiring: Factory installed, with bundling, lacing, and protection included; flexible conductors for #8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchgear, with wire markers at each end of control wiring.

F. Control power to supply individual circuit breaker trip unit. Coordinate supply voltage and current requirements with trip unit. No more than four (4) trip units are to be daisy chained together from the same source wiring and each vertical section is to have its own dedicated wiring back to control power source. For double ended systems, provide a minimum of two control power sources to supply the left and right halves of the switchboard. The tie breaker trip unit is to be connected to both power supplies.

G. Communications Gateway: Provide network switch and gateway to collect individual trip unit and meter network connections to allow for a single network connection to customer's LAN and/or BAS system. Coordinate requirements with LAN system administrator and BAS system provider. Gateway is to be powered from switchboard control power source. Gateways in double-ended switchboards are to be powered from both incoming source control power supplies.

H. Automatic-Throw-Over (ATO) Controller (where indicated on single-line diagram):
   1. Microprocessor-based, or PLC-based controller for monitoring and controlling main and tie breakers. HMI is to be provided to allow operator to monitor system position, utility availability, set parameters, and control circuit breakers manually.
   2. ATO controller to electrically interlock and electrically operate main and tie breakers.
   3. ATO controller to monitor line and load side of main breakers.
   4. ATO controller to monitor both bus sides of tie breaker.
   5. ATO controller to monitor position of main and tie breakers.
   6. ATO controller is to have programmable pick-up and drop-out settings for voltage and frequency and programmable transition delay settings.
   7. ATO to receive control power from control power transformers in switchgear (originating from both sides to allow for single source outage).
   8. Provide all necessary relays for bus synchronization check and system protection.
   9. Sequence of Operations:
      a. Normal condition is with main breakers closed and tie breaker open.
      b. The tie breaker is allowed to be closed by the ATO controller manually if the controller detects the two sources to be synchronized. The user is to indicate which main breaker is to be opened prior to the tie breaker being closed. The ATO controller is to automatically close the tie breaker before opening the selected main breaker (closed transition).
      c. If the two sources are not synchronized, the closed transition function is to be prohibited by the ATO controller.
      d. A normal power failure on one or both sources is detected by ATO controller. If both sources are lost, system remains in last set position.

e. If a single source is lost, that source breaker is opened, and the tie breaker is closed. The HMI screen is to indicate the source status (available, unavailable) and circuit breaker positions at all times.

f. After a return of both sources, the status screen HMI indicates both sources are available.

g. The ATO controller and/or synch check relay checks synchronization of the two sources.

h. If the two sources are synchronized, the open source breaker can be allowed to close before the tie breaker is opened (closed transition).

i. If the two sources are not synchronized, the ATO controller prohibits the open source breaker from being closed until the tie breaker is opened (open transition).

j. A return to normal condition is initiated after a programmed delay period. If one or both sources are lost during the delay period, the delay clock starts over.

k. Upon detection of loss of control power from station battery, ATO controller is alarm from internal super-capacitor source for 30 min and close a form-c contact for remote monitoring.

l. Refer to drawings for additional requirements.

I. 125V DC Battery Plant

1. Provide sufficient lead-calcium batteries to support ATO and protection relays in a standby mode for a period of 8 hours.
2. Provide charger to support battery plant with voltage and charge current meter. Charger is to be sized to charge plant from a discharged state to fully charged state in 8 hours.
3. Provide normally open and normally closed contacts that function when the plant voltage drops below 15% of fully charged state and charger is not functioning.
4. Provide epoxy-coated, steel rack for batteries.

2.9 ACCESSORY COMPONENTS AND FEATURES

A. Furnish portable test set to test functions of circuit breakers and solid-state trip devices without removal from switchgear. Include relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit-breaker lifting devices, mounted at top front of switchgear, with hoist and lifting yokes matching each drawout circuit breaker.

E. Furnish set of tools for manually charging circuit breaker stored energy device.

F. Furnish racking handle to manually move circuit breaker between connected and disconnected positions.

G. Lockout Devices: Circuit breakers with integral, lockout/tagout devices.

2.10 METERING

A. Per requirements in Section 26 2713 – Electrical Metering.

PART 3 - EXECUTION

3.1 COORDINATION

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:
   1. Concrete: Per requirements in Division 03 – Concrete.
   2. Dimensions: Per requirements in Section 26 0529 – Hangers and Supports for Electrical Systems.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Coordinate utility company metering equipment requirements.

E. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive switchgear for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchgear mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install switchgear in accordance with applicable portions of ANSI/NECA 400.

B. Switchgear mounting
   1. Bolt switchgear to concrete housekeeping pads, using anchor bolts in accordance with Section 26 0529 – Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pads.

C. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification for switchgear, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of switchgear using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate switchgear manufacturer's name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA 3-phase symmetrical) and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include circuit, load and area served, voltage/phase rating, and fuse size and type, when applicable.

D. Provide framed, printed operating instructions for switchgear, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchgear.

E. Install switchgear in dedicated electrical space per NFPA 70, and as indicated on drawings.

F. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

G. Install control power fuses at job site per requirements in Section 26 2813 – Fuses.

H. Connect surge protective devices to switchgear bus per requirements in Section 26 4300 – Surge Protective Devices.

I. Install utility company metering equipment, devices and wiring in conformance with serving utility requirements.

J. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

K. Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.4 CONNECTIONS

A. Ground switchgear according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect switchgear for physical damage, proper alignment, connections, anchorage, and grounding.

B. Test continuity of each circuit.

C. Test switchgear per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Set field-adjustable circuit breakers trip settings, to values indicated on drawings or recommended by the overcurrent protective device coordination study per Section 26 0573 – Overcurrent Protective Device Coordination Study.

B. Field adjustments of trip setting and adjustment or replacement of equipment to comply with Section 26 0573 – Overcurrent Protective Device Coordination Study; no additional cost to Owner.

3.8 CLEANING

A. Clean switchgear during construction phase, prior to initial testing and energization, and prior to final punch list, after other trades have departed. Cleaning procedures shall be as follows:

1. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.
2. Rack out circuit breakers and remove arc chutes.
3. Wipe down surfaces, including arc chutes and circuit breakers with Endust or equivalent.
4. Use paintbrush to dust small, hard-to-reach crevices.

3.9 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner's personnel in the operation and maintenance of switchgear.

END OF SECTION

SECTION 26 2313

PARALLELING LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 260526 – Grounding and Bonding for Electrical Systems

C. Section 260529 – Hangers and Supports for Electrical Systems

D. Section 260553 – Electrical Systems Identification

E. Section 260573 – Power System Studies

F. Section 260812 – Power Distribution Acceptance Tests

G. Section 260813 – Power Distribution Acceptance Test Tables

H. Section 262813 – Fuses

I. Section 263213 – Engine Generators

J. Section 263623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes free-standing, dead-front type, metal-enclosed, low-voltage distribution switchgear and associated monitoring and control systems, for paralleling 4 generators on an isolated bus, and distributing generator power.

1.4 REFERENCE STANDARDS

A. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures

B. IEEE C37.20.1 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

C. IEEE C37.90 – Relay and Relay Systems Associated with Electric Power Apparatus

D. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

E. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

F. NFPA 70 – National Electrical Code

G. NEMA 2250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

H. UL 486A-486B – Wire Connectors

I. UL 869A – Reference Standard for Service Equipment

J. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

K. UL 1558 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.5 SUBMITTALS

A. Product Data: For switchgear, components and accessories indicated:
   1. Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size, switching and overcurrent protective devices.
   2. Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.
   3. Description of sequence of operation for paralleling controls.

B. Shop Drawings:
   1. For switchgear specified in this Section:
      a. General Arrangement:
         1). Indicate front, plan, and side views of switchgear; access requirements; overall dimensions and components list; shipping splits and weights.
         2). Front elevation indicating location of devices and instruments.
         3). Sections through switchgear showing space available for conduits.
      b. Conduit entrance locations and requirements.
      c. Nameplate legends
      d. Configuration, size and number of bus bars for each phase and current rating of buses.
      e. Ground bus
      f. Neutral bus
      g. Short circuit ratings of switchgear and overcurrent protective devices, and bus withstand rating
      h. Instrument details; enclosure types and details
      i. Wiring diagrams: power, signal and control wiring
      j. Wiring diagrams showing connections of component devices and equipment
      k. Schematic control diagrams
      a. Diagrams of current and future circuits showing device terminal numbers and internal diagrams
      b. Schematic diagrams showing connections to remote devices
      c. Mimic-bus diagram; samples: representative portion of mimic bus with specified finish, for color selection
   2. Submit 1/4” scale floor plans with switchgear location and required clearances and service space around equipment.

C. Manufacturer’s Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports:
   1. Provide factory test report
   2. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

F. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations, configurations, and ratings of switchgear and major components on single-line diagrams and plan layouts.
      b. Updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.
   2. Operation and Maintenance Data:
      a. Include manufacturer's written instructions for sequence of operation.
      b. Include manufacturer's sample system checklists and log sheets.
      c. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      d. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      e. Include spare parts data listing, source, and current prices of replacement parts and supplies.
      f. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

A. Obtain switchgear from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NEC for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Factory Test
   1. Test paralleling system in accordance at the factory in accordance with Section 260812 - Power Distribution Acceptance Tests and Demonstration of Switchgear Functions.
   2. Provide factory test report

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver switchgear in 48” maximum width shipping splits individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 WARRANTY

A. Refer to Division 01 and Section 260000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 2 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.
   2. Control-Power Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Russelectric

2.2 RATINGS

A. As Scheduled

2.3 CONSTRUCTION

A. IEEE C37.20.1, UL 1558

B. Free-standing, dead-front type; metal-enclosed; side, front and rear panels of one-piece welded or bolted construction; compartments with ventilation louvers in top and bottom sections of front and rear panels; supporting frame: steel channels rigidly fastened together, with same outside dimensions as enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

E. Environmental Limitations:
   1. Ambient temperatures: not exceeding 40°C

2. Altitude: Not exceeding 2000m.
3. Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.

F. Device Mounting and Type:
1. Front and rear accessible switchgear
a. Generator and feeder devices: Drawout and compartmented power circuit breakers.

G. Bus:
1. Material: Copper with silver plating; copper: 98% conductivity.
2. Connections: Accessible from rear only for maintenance.
a. Bolted:
1). Not fewer than 4 bolts for each 4” x 4” contact.
2). Not fewer than 2 bolts for each 2” x 2” contact.
3). Grade 5 bolts and conical spring-type washers
3. Sizing: Standard size, based on 65°C over 40°C; full capacity of the breaker frame size, not the trip setting; fully rated vertical and horizontal bus sections.
4. Main Phase Buses: 3 phase, **4** wire; uniform capacity for entire length of switchgear; ampacity as indicated on drawings; rated for paralleled engine capacity.
5. Bus Arrangement: A-B-C (left to right, top to bottom, front to rear).

H. Ground Bus: extend length of switchgear.
1. 1600 A, hard-drawn copper of 98% conductivity, equipped with pressure connectors for feeder ground conductors.

I. Hinged Front Doors: Allow access to metering, accessory, and blank compartments, with latch and padlocking provisions.

J. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchgear, with latch and padlocking provisions.

K. Circuit breaker compartment: Equipped to house drawout type circuit breakers, fitted with hinged outer doors, and segregated from adjacent compartments by steel barriers; equipped with drawout rails, levering out mechanism, primary and secondary contacts; The following functions may be performed without need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

L. Section barriers between generator and master control compartment: Extended to rear of section; rear compartment barrier between cable compartment and main bus; glass polyester barrier between adjacent vertical structures in cable compartment.

M. Bus isolation barriers: Arranged to isolate line bus from load bus at each generator circuit breaker; separate barriered compartment for current and potential transformers; main and riser buses fully isolated from breaker instrument and auxiliary compartments.

N. Bus bars connect: Between vertical sections and between compartments. Cable connections are not permitted.

O. Safety shutter: To automatically cover line and load stubs to protect against accidental contact.

P. Provide a 4” diameter polymer lens infrared (IR) scanning window for each set of circuit breaker terminations, mounted on cable compartment door.

Q. Spare circuit breakers and spaces for future circuit breakers: Allowance in vertical section bus size.

R. Adequate lifting means.

S. Line and Load Terminations: Compression type, labeled for 75°C copper and aluminum conductors; suitable for number, sizes and trip ratings; feeder load terminals: silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.

T. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation, or fluidized epoxy coating. No live connections shall be accessible from the rear, except breaker load side terminals.
   1. Sprayed Insulation Thickness: 3 mils, minimum.
   2. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

U. Relays: IEEE C37.90; types and settings as indicated; with test blocks and plugs.

V. Enclosure: Steel, NEMA 250, Type 1
   1. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer’s standard gray finish over rust-inhibiting primer on treated metal surface.
   2. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer’s standard color, undersurfaces treated with corrosion-resistant undercoating.

2.4 GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

A. Paralleling control reliability. Redundant distributed processing or redundant master control to prevent loss of paralleling control.

B. Individual Generator Control and Monitoring: Provide each generator with control and monitoring components to view status and control operation of respective generator.
   1. Mount components and devices in a section of the switchgear lineup dedicated for each generator. Dual generator sections are not acceptable. Each section shall have the following features and characteristics:
   2. Generator Metering: 1% accuracy class or better.
      a. Ammeter, Voltmeter, Frequency Meter, Wattmeter, Kilowatt-Hour Meter, and Power Factor Meter:
         1). For 3-phase and 4-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.
         2). Provide analog devices for voltmeter and frequency meters.
         3). Provide switches or other provisions to allow reading of both generator and bus voltages and frequencies from this metering set.
      b. Synchroscope and “Generator Set Synchronized” Indication
         1). Provide lamp or LED indication of synchronization.
         2). Provide 360-degree analog movement synchroscope.
      c. Engine run-time meter, start counter, rpm meter, and battery voltage meter.

d. Engine oil temperature gage and engine coolant temperature gage.

3. Generator Protective and Control Switches: Provide oil tight, industrial-grade switches.
   a. Mode Selector Switch (Run/Off/Auto):
      1). "Run" mode to start and accelerate unit to rated speed and voltage, but not close paralleling circuit breaker.
      2). "Off" mode to prevent generator from starting or to immediately shutdown generator if running.
      3). "Auto" mode to start generator on receipt of remote start signal.
   b. Circuit-Breaker Trip/Close Switch: Interlocked with system control so that circuit-breaker closure is impossible unless the following occurs:
      1). Mode selector switch is in "Run" position.
      2). Generator set is synchronized with system bus.
   c. Control/reset push button with flashing lamp to indicate generator is locked out due to fault condition.
   d. Lamp test push button to simultaneously test all lamps on panel.
   e. Control Panel Illumination: DC lamps to illuminate panel when lighting from surrounding environment is not available.
   f. Emergency Stop Push Button: Red mushroom-head switch maintaining its position until manually reset.
   g. Voltage and Frequency Raise/Lower Switches:
      1). Allow ±5% adjustment when generator set is operating but not paralleled. The following paragraphs are optional but recommended for outdoor applications.
4. Generator Protective and Control Devices: Solid-state industrial relays, integrated microprocessor-based control devices, and other accessories and devices located either in generator control and monitoring panel or in switchgear control section to provide the following features and functions:
   a. Kilowatt Load Sharing Control:
      1). Operates engine governors during synchronizing and provides isochronous load sharing when paralleled.
      2). Allows generator set to ramp up to kilowatt load level signaled by system master controller.
   b. Load-Demand Governing Control:
      1). Causes generator set to ramp down to zero load when signaled to shut down in load-demand mode.
      2). Causes generator set to ramp up to a proportional share of total bus load.
   c. Kilovolt Ampere Rating Load Sharing Control
      1). Operates alternator excitation system while generator set is paralleled.
      2). Causes sharing of reactive load among all generator sets to within 1% of equal levels without voltage drop.
   d. Sync-Check and Paralleling Monitor and Control:
      1). Monitors and verifies that generator set has reached 90% of nominal voltage and frequency before closing to bus.
      2). Prevents out-of-phase paralleling if two or more generator sets reach operating conditions simultaneously, by sending "inhibit" signal to sets not designated by system as "first to close to bus."

3). Recognizes failure of “first-to-close” generator set and signals system paralleling to continue.

4). Prevents out-of-phase closure to bus due to errant manual or automatic operation of synchronizer.

e. Synchronizer Control:

1). Adjusts engine governor to match voltage, frequency, and phase angle of paralleling bus.

2). Maintains generator-set voltage within 1% of bus voltage, and phase angle within 20 electrical degrees of paralleling bus for 0.5 seconds before circuit-breaker closing.

3). Provides “fail-to-synchronize time delay” adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down generator set on failure condition.

f. Reverse Power Monitor and Control:

1). Verifies generator set and paralleling bus phase rotation match prior to closing paralleling circuit breaker.

g. Phase Rotation Monitor and Control:

1). Verifies generator set and paralleling bus phase rotation match prior to closing paralleling circuit breaker.

h. Electronic Alternator Overcurrent Alarm and Shutdown Control:

1). Monitors current flow at generator-set output terminals.

2). Initiates alarm when load current on generator set is more than 110% of rated current for more than 60 seconds.

3). Provides overcurrent shutdown function matched to thermal damage curve of alternator. Provide without instantaneous-trip function.

i. Electronic Alternator Short-Circuit Protection:

1). Provides shutdown when load current is more than 175% of rated current and combined time/current approaches thermal damage curve of alternator. Provide without instantaneous-trip function.

j. Loss of Excitation Monitor:

1). Initiates alarm when sensing loss of excitation to alternator while paralleled to system bus.

k. Generator-Set Start Contacts: Redundant system, 10 A at 32 VDC.

l. Cool-Down Time-Delay Control: Adjustable, 0 to 600 seconds.

m. Start Time-Delay Control: Adjustable, 0 to 300 seconds.

n. Paralleling Circuit-Breaker Monitor and Control:

1). Monitors circuit-breaker auxiliary contacts.

2). Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).

3). Trips open and locks out paralleling circuit breaker upon paralleling circuit breaker failure to close, until manually reset.

5. Engine Protection and Local Annunciation:

a. Provide annunciation and shutdown control modules for alarms indicated.

b. Provide visual alarm status indicator and alarm horn with silence/acknowledge push button on generator control and monitoring panel.

c. Annunciate the following conditions:
   1). Status, Light Only (Nonlatching):
      a). Generator engine control switch not in auto (red)
      b). Generator engine control switch in auto (green)
      c). Emergency mode (red)
      d). Generator circuit breaker closed (red)
      e). Generator circuit breaker open (green)
      f). Engine stopped (green).
      g). Engine running (red)
      h). Engine cool-down (amber)
   2). Pre-Alarm, Light and Horn (Non-latching):
      a). Pre-high coolant temperature (amber)
      b). Pre-low oil pressure (amber)
      c). Low coolant temperature (amber)
      d). Engine low battery (amber)
      e). Engine low fuel (amber)
      f). Generator fails to synchronize (amber)
   3). Shutdown Alarm, Light and Horn (Latching):
      a). Engine overcrank (red)
      b). Engine overspeed (red)
      c). Engine low oil pressure (red)
      d). Engine high coolant temperature (red)
      e). Engine low coolant level (red)
      f). Engine remote emergency shutdown (red)
      g). Generator circuit breaker tripped (red)
      h). Generator loss of field (red)
      i). Generator reverse power (red)
      j). Generator undervoltage (red)
      k). Generator overvoltage (red)
      l). Generator underfrequency (red)
      m). Generator overfrequency (red)

C. Master Control System and Monitoring Equipment: Provide paralleling and monitoring equipment components, and accessories for multiple generators with the following features and characteristics:
   1. Mount components and devices in a dedicated switchgear control section of the switchgear lineup.
   2. Paralleled System Metering: 1% accuracy class or better to monitor total output of generator bus.
      a. Ammeter, voltmeter, frequency meter, wattmeter, kilowatt-hour meter, power factor meter, kilovolt ampere rating, and kilowatt demand meters.
         1). For 3-phase/4-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.

2). Display functions on the human machine interface device.

3. Full-Color Human Machine Interface (HMI) Device
   a. Provide three (HMI) devices:
      1). Located at the paralleling gear
      2). Located at Level 0 ATS Room
      3). Located at Level 8 ATS Room
   b. Provide means to monitor and control the complete system of paralleled generator sets.
   c. Screens shall include the following:
      1). Main Menu: Include date, time and system status messages with screen push buttons to access one-line diagram, system controls, load controls, alarms, bus metering, and individual generator-set data.
      2). One-Line Diagram Screen: Depict system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators. Indicate the following minimum system conditions:
         a). Generator sets, buses, and paralleling circuit breakers energized/de-energized.
         b). Generator set mode (run/off/auto).
         c). Generator set status (normal/warning/shutdown/load-demand stop).
         d). Paralleling circuit-breaker status (open/closed/tripped).
         e). Bus conditions (energized/de-energized).
         f). Provide access to other screens.
      3). AC Metering Screen: Display the following minimum meter data for the paralleling bus:
         a). Phase volts and amperes, Kilowatts, Kilovolt Amperes, Kilovolt Ampere Rating, power factor, frequency, Kilowatt/hr, Kilowatt demand.
         b). Real-time trend chart for system Kilowatt and Volts updated on not less than one-second intervals.
         c). Minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and a minimum duration of four hours.
      4). Generator-Set Control Screen: Provide control over individual generator sets from master system control panel. Include the following minimum functions:
         a). Generator manual start/stop control (functional only when generator-set mounted control switch is in “Auto” position).
         b). Generator-set alarm reset.
         c). Manual paralleling and circuit-breaker controls.
      5). Generator-Set Data Display Screen: Provide the following minimum parameters:
         a). Engine speed, oil pressure and temperature, coolant temperature, and engine operating hours.
         b). Three-phase voltage and current, kW, PF, and kW/hr.
         c). Generator control switch position and paralleling circuit-breaker position.
         d). Generator-set alarms.
      6). System Control Screen: Password protected and with the following minimum functions:
         a). System Test Modes: Test with load/test without load/normal/retransfer time-delay override.

b). Test with Load: Starts and synchronizes generator sets on paralleling bus but does not transfer loads to bus.

c). Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

7). Load-Demand Control Screen: Monitor total load on system bus and control number of generator sets running to match capacity with load demand. Provide the following:

a). Load-Demand Control: On/off.

b). Load-Demand Pickup set Point: Adjustable from 90 to 40% in 5% increments.

c). Load-Demand Dropout Set Point: Adjustable from 20 to 70% in 5% increments.

8). Manual Load Control Screen: Provide screen to manually add or delete generator sets from paralleled system in response to system load parameters. Provide the following:

a). Indicate available system in kW and amp.

b). Control functions to allow manual addition/removal of generator sets on system, and to activate load-shed/load-restore functions.

9). Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:

a). "Load-add sequence priority" assignment to each load control relay with designation for relay operation after a set number of generator sets are online.

b). "Load-shed sequence priority" assignment to each load control relay with designation for relay operation depending on number of generator sets online.

10). Alarm Summary and Run Report Screen:

a). Lists most recent alarm conditions and status changes.

b). Lists a minimum of the most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.

c). For each start signal, lists start time and date, stop time and date, maximum kW and ampere load on system during run time, and start and stop times of individual generator sets.

11). *ATS Monitoring and Control Screen – Central Utility Plant and Hospital ATS's*

a). Show each ATS with its unique identification arranged by priority

b). Show position of each ATS

c). Show load in KW and Voltage of each ATS

d). Be able to change position of ATS if both sources are accepted

e). Be able to initiate ATS test

12). *Fuel System Monitoring Screen:*

a). Monitor fuel management system and display:

a General Alarms

b Day tank levels in %

c Day tank pumps running/off

d Bulk tank level in %

e Bulk tank level in gallons

~~c).~~

4. Solid-State System Status Panel:

a. Provides visual alarm status indicator and alarm horn with silence/acknowledge push button.
b. Annunciates the following conditions:
1). Status, Light Only:
a). Running Status: Display generator set number and “green” running-status light
b). Load demand mode (green)
c). Priority Load Status: display load number and “green” on-status light
d). System test (green)
e). Remote system start (red)
f). Normal source available (green)
g). Connected to normal (green)
h). Generator source available (green)
i). Connected to generator source (green)
2). Status, Light and Alarm:
a). Load-Shed Level Status: Displays load number and red load-shed status light
b). Generator Alarm Status: Displays generator number and red “Check Generator” status light
c). Controller malfunction (red)
d). Check station battery (red)
e). Bus overload (red)
f). System not in auto (red)

5. *Communications with Transfer Switches*
a. *Paralleling system receives hard-wired engine start contact closure from each ATS (Central Utility Plant and Hospital)*
b. *Paralleling system sends hard-wired load shed/add signals to transfer switches*
c. *Provide Fiber RTU for remote transfer switch communications to monitor ATS metering and status information*
6. *Communications with BAS System*
a. *Provide BACNET communication to BAS system to allow monitoring of all paralleling gear functions.*
b. *Mimic paralleling gear HMI interface screen to show status of all systems, but BAS system is not to allow control of paralleling gear.*
~~f).~~

D. Description of System Operation:
1. Loss of Normal Power:
a. System receives “start” signal from any ATS; all generator sets start and achieve rated voltage and frequency.
b. System closes the first generator set achieving 90% of rated voltage to paralleling bus.
c. “Priority load add” controls prevent overloading of system. System to provide minimum of 32 independent load add levels to control each transfer switch individually.
d. Remaining generator sets switched to synchronizers that control and allow closure of generator sets to paralleling bus.

e. On closure to paralleling bus, each generator set assumes its proportional share of total load.
f. Tie breaker closes once all generators are connected to the paralleling bus. Tie breaker remains closed after a loss of one or more generators from the bus.

2. Failure of a Generator Set to Start or Synchronize:
   a. After expiration of overcrank time delay, generator set shuts down and alarm is initiated.
   b. Priority controller prevents overload of system bus.
   c. Manual override of priority controller at HMI allows addition of low-priority load to bus.
   d. Bus overload monitor protects bus from manual overloading.
3. Bus Overload:
   a. On bus overload, load-shed controls initiates load shedding.
   b. If bus does not return to normal frequency within adjustable time period, additional load continues to be shed until bus returns to normal frequency.
   c. Loads shed can be reconnected to bus only by manual reset at HMI.
4. Load-Demand Mode:
   a. With “load-demand” function activated, controller continuously monitors total bus load.
   b. If bus load is below preset limits for 15 minutes, demand controller shuts down generator sets in predetermined order until minimum number of sets are operating.
   c. On sensing available bus capacity diminished to set point, controller starts and closes generator sets to bus to accommodate load.
5. Return to Normal Power:
   a. Process starts on removal of start signals from system.
   b. When no load remains on paralleling bus, all generator breakers open, go through cool-down period, and shut down.
   c. If start signal is received during cool-down period, one generator set is reconnected to bus, and system operation follows that of “loss of normal power.”
   d. Tie breaker remains closed until all generators have been removed from the bus.
6. Failure of a Generator Controller or Master Controller:
   a. Redundant processors allow engines to perform all 5 modes of operation.

2.5 JOINT COMMISSION REPORTING SYSTEM

A. Integrated Server for Producing Joint Commission Reports
   1. Automated reporting system triggered by ATS engine start signal causing system to begin emergency mode
   2. Report captures the following parameters for each emergency mode event:
      a. ID of ATS initiating system emergency mode
      b. Date and Time of day of initiating event
      c. Each ATS ID included in event transmitting engine start signal
      d. Average KW load measured on each ATS during event
      e. Number of minutes each ATS connected to emergency source
      f. Generator ID required to run and connect to bus during event
      g. Each generator average and peak KW during event
      h. Generator exhaust stack temperature for each generator running during test

i. Total generator run time in minutes for each gen connected during event
j. Date and Time of Day of when event is cleared and system returned to normal

3. Server stores all reports and allows retrieval of reports locally at HMI or remotely via network connection. Reports are accessible via standard software package not requiring subscription or license.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Power Circuit Breaker and Accessories: ANSI/IEEE C37.13; UL 1066; metal frame; field interchangeable electrical accessories, including shunt trip, spring release, electrical operator, auxiliary contacts and trip unit.

1. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   a. Normal Closing Speed: Independent of both control and operator.
   b. Slow Closing Speed: Optional with operator for inspection and adjustment.
   c. Store-Energy Mechanism: Electrically charged, with optional manual charging.
   d. Means for manual opening and closing
   e. Operation counter
3. Trip Devices: Electronic (solid-state, microprocessor-based), overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and features per Subparagraph 2.6 B in this Section.
4. Drawout Features: Circuit breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
   a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
   b. Circuit Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from structure with door open. Status for connection devices for different positions includes the following:
      1). Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
      2). Disconnected Position: Primary and secondary devices and ground contact disengaged.
5. Auxiliary Contacts: For interlocking or remote indication of circuit breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit breaker operation. Each consists of two type “a” and two type “b” contacts wired through secondary disconnect devices to a terminal block in stationary housing; “a” contacts mimic circuit breaker contacts, “b” contacts operate in reverse of circuit breaker contacts.
6. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
7. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

8. Electric Close Button: One for each electrically operated circuit breaker.
9. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
10. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key interlock devices is indicated.
11. Shunt-Trip Devices: Where indicated.
12. Indicating Lights: To indicate circuit breaker is open or closed, interlocked circuit breakers.
13. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 – Electrical Power Monitoring and Control.
14. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault protection function, and/or short time function.
15. Control Voltage: 120 VDC.
16. Trip Voltage: 24 VDC, close and charge.
17. Listed for 100% of breaker's continuous ampere rating.

B. Circuit Breaker Electronic Trip Unit general characteristics:
1. Circuit breakers, with solid-state microprocessor based trip units:
   a. Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
   b. Trip units shall be removable to allow for field upgrades.
   c. Trip units shall incorporate "True RMS Sensing."
2. Solid-state elements shall provide functions as indicated above.
3. Adjustments shall be made using non-removable, discrete steps.
4. Sealable transparent cover shall be provided over adjustments.
5. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL listed as field-replaceable. Adjustable rating plug shall allow for 5 minimum long-time pickup settings from 0.4 to 1.0 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be at least 3 bands.
6. Short-time pickup shall allow for 5 minimum settings from 1.5 to 10 times Ir. Short-time delay shall be at least 3 bands with I^2t ON and OFF.
7. Instantaneous settings on the trip units shall be available in 5 minimum bands from 2 to 15 times In. The instantaneous settings shall also have an OFF setting when short-time pickup is provided.
8. Trip units shall have the capacity to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be 1 amp. Fine increments for delay adjustments are to be 1 second.
9. Trip unit shall Indicate:
   a. Long-time fault
   b. Short-time fault
   c. Instantaneous fault
   d. Ground fault, where provided
10. Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.

11. Trip unit shall contain means to conduct circuit breaker tests, or via separate test kit.
12. Breaker shall be equipped with externally accessible test points to be used for field testing.
13. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.
14. Trip units shall be provided with the following standard features:
    a. True RMS sensing
    b. LI
    c. LSI
    d. LSIG/Ground-fault trip where indicated
    e. Ground Fault Alarm (no trip), with external relay, where indicated
    f. Adjustable rating plugs
    g. LCD or LED – Long-time pickup
    h. LCD or LED – Trip indication
    i. Communications for power monitoring capabilities
    j. Ammeter
    k. LCD dot matrix display
    l. Advanced user interface
    m. Protective relay functions
    n. Neutral protection
    o. Incremental fine tuning of settings
    p. Selectable long-time delay bands
    q. Power measurement
    r. Maximum peak demand (measure of average power over a 15-minute period) continuously recorded over a one-year period

C. Ground Fault protection equipment on breakers, where indicated: Integrally mounted relay and trip unit, push-to-test feature and ground fault indicator:
    1. Ground-fault protection with at least three adjustable short-time-delay settings and three trip-time-delay bands; adjustable current pickup with maximum setting of 1200 A. Arrange to provide protection for the following:
        a. 3-wire circuit or system
        b. 4-wire circuit or system
        c. 4-wire, double-ended substation
    2. Provide trip units capable of the following types of ground-fault protection: source ground return, residual, zero sequence. Ground-fault sensing systems shall be changed in the field.
    3. Neutral current transformers shall be provided for 4-wire system.
    4. Provide ground-fault settings for circuit breaker sensor sizes 1200 amp or below with 9 bands from 0.2 to 1.0 times In. Provide ground-fault settings for circuit breakers above 1200 A with minimum 3 bands up to 1200 A.
    5. Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.

D. Arc Energy Reduction

1. Where the highest continuous current trip setting for which the actual overcurrent device is rated or can be adjusted is 1200A or higher, an energy-reducing maintenance switch with local status indicator shall be provided.

2.7 CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

A. Control Circuits: 120 VDC, supplied through secondary disconnecting devices from control-power DC battery plant. Provide VRLA battery plant capable of supplying standby control power for 8 hours with the ability to cycle each circuit breaker twice at that end of the 8 hour standby period.

B. Provide best battery automatic source selector to allow control system to be powered from control power source or DC battery plant.

C. Electrically Interlocked Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated primary circuit breaker. 120V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

D. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

E. Control components mounted within assembly, such as relays, pushbuttons, switches etc.: Suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

F. Control Wiring: Factory installed, with bundling, lacing, and protection included; flexible conductors for #8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for all control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchgear, with wire markers at each end of control wiring.

G. *125V DC Battery Plant*

1. *Provide sufficient lead-calcium batteries to support ATO and protection relays in a standby mode for a period of 8 hours.*
2. *Provide charger to support battery plant with voltage and charge current meter. Charger is to be sized to charge plant from a discharged state to fully charged state in 8 hours.*
3. *Provide normally open and normally closed contacts that function when the plant voltage drops below 15% of fully charged state and charger is not functioning.*
4. *Provide epoxy-coated, steel rack for batteries.*

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Furnish portable test set to test functions of circuit breakers and solid-state trip devices without removal from switchgear. Include relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

C. Furnish 1 portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit-breaker lifting devices, mounted at top front of switchgear, with hoist and lifting yokes matching each drawout circuit breaker.

E. Furnish set of tools for manually charging circuit breaker stored energy device.

F. Furnish racking handle to manually move circuit breaker between connected and disconnected positions.

G. Lockout Devices: Circuit breakers with integral, lockout/tagout devices.

PART 3 - EXECUTION

3.1 COORDINATION

A. Instruct manufacturer about location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:
   1. Concrete: Per requirements in Division 03 – Concrete.
   2. Dimensions: Per requirements in Section 260529 – Hangers and Supports for Electrical Systems.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive switchgear for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchgear mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install switchgear in accordance with applicable portions of ANSI/NECA 400.

B. Install engraved plastic nameplates under provisions of Section 260553 – Electrical Systems Identification for switchgear, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of switchgear using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate switchgear manufacturer’s name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amperes, RMS symmetrical and MVA three-phase symmetrical) and momentary and fault-closing ratings (amperes, RMS asymmetrical). For each overcurrent protective device and disconnect device,

include circuit, load and area served, voltage/phase rating, and fuse size and type, when applicable.

C. Provide framed, printed operating instructions for switchgear, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchgear.

D. Install switchgear in dedicated electrical space per NFPA 70, and as indicated on drawings.

E. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

F. Install fuses in fusible switch at job site per requirements in Section 262813 – Fuses.

G. Install surge arrestors in cable termination compartments and connect to each phase of circuit, per requirements in Section 264300 – Surge Protective Devices.

H. Connect surge protective devices to switchgear bus per requirements in Section 264300 – Surge Protective Devices.

I. Install utility company metering equipment, devices and wiring in conformance with serving utility requirements.

J. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

K. Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.4 CONNECTIONS

A. Ground switchgear according to Section 260526 – Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 260519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 ACCEPTANCE TESTING

A. Testing by Electrical Contractor

B. Perform acceptance testing – Section 260812 – Power Distribution Acceptance Tests and Section 260813 – Power Distribution Acceptance Test Tables. Interpret test results in writing and submit to Engineer.

C. Manufacturer's Field Service:

1. Engage factory-authorized service representative to inspect, and adjust field assembled components and equipment installation, including connections.

D. Adjust or replace equipment as needed to comply with manufacturer's specifications and submit new test reports.

3.6 FIELD QUALITY CONTROL

A. Inspect switchgear for physical damage, proper alignment, connections, anchorage, and grounding.

B. Test continuity of each circuit.

3.7 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.8 ADJUSTING

A. Set field-adjustable circuit breakers trip settings, to values indicated on drawings or recommended by the overcurrent protective device coordination study per Section 260573 – Power System Studies.

B. Field adjustments of trip setting and adjustment or replacement of equipment to comply with Section 260573 – Power System Studies; no additional cost to Owner.

3.9 CLEANING

A. Clean switchgear during construction phase, prior to initial testing and energization, and prior to final punch list, after other trades have departed. Cleaning procedures shall be as follows:
   1. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.
   2. Rack out circuit breakers and remove arc chutes.
   3. Wipe down surfaces, including arc chutes and circuit breakers with Endust or equivalent.
   4. Use paintbrush to dust small, hard-to-reach crevices.

3.10 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner’s personnel in the operation and maintenance of switchgear.

END OF SECTION 262313

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SECTION 26 2413

SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

G. Section 26 2713 – Electrical Metering

H. Section 26 2813 – Fuses

I. Section 26 4300 – Surge Protective Devices

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes free-standing, dead-front type low-voltage distribution switchboards.

1.4 REFERENCE STANDARDS

A. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures

B. ANSI/NECA 400 – Recommended Practice for Installing and Maintaining Switchboards

C. IEEE C62.11 – Metal-Oxide Surge Arresters for Alternating Current Power Circuits

D. IEEE C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

E. NFPA 70 – National Electrical Code

F. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

G. NEMA AB 3 – Molded-Case Circuit Breakers and Their Applications

H. NEMA FU 1 – Low-Voltage Cartridge Fuses

I. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

J. NEMA LA 1 – Surge Arresters

K. NEMA PB 2 – Dead-Front Distribution Switchboards

L. NEMA PB 2.1 – General Instructions for Proper Handling, Installation and Maintenance of Dead-Front Distribution Switchboards Rated 600 Volts or Less

M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

N. UL 98 – Enclosed and Dead-Front Switches

O. UL 486A-486B – Wire Connectors

P. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

Q. UL 869A – Reference Standard for Service Equipment

R. UL 891 – Dead-Front Switchboards

S. UL 1053 – Ground-Fault Sensing and Relaying Equipment

T. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.5 SUBMITTALS

A. Product Data: For each switchboard, components and accessories indicated:
   1. Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of surge protective devices, switching and overcurrent protective devices.
   2. Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.

B. Shop Drawings:
   1. For each switchboard specified in this Section:
      a. General Arrangement:
         1) Indicate front, plan, and side views of switchboards; access requirements (front, side, rear); overall dimensions and components list; shipping splits and weights.
         2) Front elevation indicating location of devices and instruments.
         3) Sections through switchboard showing space available for conduits.
      b. Conduit entrance locations and requirements.
      c. Nameplate legends.
      d. Configuration, size and number of bus bars for each phase and current rating of buses.
      e. Ground bus.
      f. Neutral bus.
      g. Short circuit ratings of switchboards and overcurrent protective devices, and bus withstand rating.

h. Instrument details; enclosure types and details.
i. Wiring diagrams: power, signal and control wiring.
j. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

2. Contractor to submit 1/4" scale floor plans with switchboard locations and required clearances and service space around equipment.

C. Manufacturer's Installation Instructions:
1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

F. Closeout Submittals:
1. Project Record Documents:
a. Record actual locations, configurations, and ratings of switchboard and major components on single-line diagrams and plan layouts.
2. Operation and Maintenance Data:
a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
d. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

A. Obtain switchboards from one source and by single manufacturer.

B. Regulatory Requirements:
1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchboards as required to prevent condensation.

B. Deliver switchboards in shipping splits of length that can be moved in delivery path to final location in project, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes,

and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Handle switchboards in accordance with NEMA PB 2.1 and ANSI/NECA 400. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Fuses for Fused Switches and for Fused Circuit Breakers: Equal to 10% of amount installed for each size and type, but no fewer than 3 of each size and type

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D – Schneider Electric

B. ABB - General Electric

C. Siemens

2.2 RATINGS

A. Nominal system voltage: As indicated on the drawings or scheduled.

B. Main bus continuous amp: As indicated on the drawings or scheduled.

C. Short circuit current rating: As indicated on drawings.

D. Brace switchboard components to withstand mechanical forces for symmetrical fault current shown.

2.3 CONSTRUCTION

A. NEMA PB 2, UL 891

B. Free-standing, dead-front type; vertical sections bolted together; sides and rear covered with removable bolt-on covers; adequate ventilation within enclosure; supporting frame: steel channels rigidly fastened together, with same outside dimensions as the enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Incoming lug locations: as applicable per drawings.

E. Connection to the supply source by conduit and wiring.

F. Environmental Limitations:
   1. Ambient temperatures: Not exceeding 40°C.
   2. Altitude: Not exceeding 6600 ft
   3. Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.

G. Device Mounting and Type:
   1. Front accessible switchboard: Front and rear aligned for free standing installation have rear and side access or front and side access only for placement against the wall, as indicated by drawings:
      a. Main device: Fixed (individually) mounted insulated-case circuit breaker or fusible switch as indicated on drawings.

H. Bus:
   1. Material: Copper with silver plating; copper: 98% conductivity. The bus bars shall have sufficient cross-sectional area to meet UL 891 temperature rise requirements through actual tests. The bus bars shall be standard density rated for 1000 amperes per square inch copper.
   2. Connections:
      a. Bolted:
         1) Not fewer than 4 bolts for each 4” x 4” contact.
         2) Not fewer than 2 bolts for each 2” x 2” contact.
         3) Grade 5 bolts and conical spring-type washers.
         4) Clamp joints are not allowed.

   3. Sizing: Standard size, based on 65°C rise over 40°C ambient.
   4. Main Phase Buses: Three phase, 3 or 4 wire as indicated on drawings; fully rated; uniform capacity for entire length of switchboard; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.
   5. All feeder device line and load connection detail: Rated to carry current rating of device frame (not trip rating).
   6. Support for Buses: Mounted on high-impact, non-tracking insulated supports; joints in the vertical bus are not permitted.
   7. Bus arrangement: A-B-C (left to right, top to bottom, front to rear).

I. Ground Bus: extend length of switchboard.
   1. 1/4” x 2” minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection.

J. Neutral Bus: 100% of the ampacity of phase buses, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

K. Hinged Front Doors: Allow access to metering and accessory compartments; concealed hinges; fastened by head bolts.

L. Device Barriers

1. Individually Mounted Devices: Between adjacent devices; between vertical sections
2. Group Mounted Devices: Between adjacent vertical sections.

M. Hinged Front Doors:
1. Over individually mounted device compartments, with concealed hinges and fastened by hex head bolts.
2. Over cable termination compartments of group mounted devices.

N. Hinged Rear Doors and Compartment Covers: With concealed hinges and fastened by hex head bolts.

O. Bus Connections: Extend from load side of individually mounted devices into cable compartment for connections to outgoing cables.

P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
1. Pull Section: Width, depth and height to match switchboard.

Q. Pull Box on Top of Switchboard:
1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Removable top, front, and sides, same construction as switchboard.
3. Insulating, fire-resistive bottom 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.
5. Set front to accommodate lifting devices for drawout circuit breakers.

R. Future Provisions: Fully equip spaces for future devices with bussing, mounting brackets, supports, and appurtenances. Spaces for individually mounted devices are to include all line and load bus detail.

S. Rail mounted trolley with lifting hoist for draw-out breakers. Trolley is to travel across top of all sections with draw-out breakers.

T. Line and Load Terminations: Allow for bolted connection of two-bolt, long barrel compression lugs. Provide holes and lug space for quantity of cables shown on drawings.

U. Provide a 4” diameter polymer lens infrared (IR) scanning window for each set of circuit breaker terminations, mounted on cable compartment panel.

V. Enclosure: Steel, NEMA 250, Type 1 for indoor installation:
1. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer’s standard gray finish over a rust-inhibiting primer on treated metal surface.

W. Mimic Bus: Black plastic 3/8” X 1/16” thick attached with rivets or stainless steel screws showing all overcurrent protection devices, current transformers, buswork, and connections. For double-ended switchboards, mimic bus is to be blue for the left feed and red for the right feed.

2.4 SERVICE ENTRANCE

A. UL 869A

B. Switchboards labeled as suitable for use as service entrance equipment, where applicable, with incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

C. Bond Neutral bus to ground bus with removable jumper sized in accordance with NEC 250.66. Label jumper “Neutral-Ground Bonding Jumper Do Not Remove Without Engineering Approval”.

D. Provide surge protection device per requirements in Section 26 4300 – Surge Protective Devices.

2.5 SHORT CIRCUIT CURRENT RATING

A. Each switchboard with minimum short circuit current rating as indicated on drawings.

B. Switchboards: Marked with their maximum short circuit current rating at supply voltage.

C. Switchboards are to be fully rated.

2.6 SURGE PROTECTIVE DEVICES (SPD)

A. Provided by installing electrician.

B. Externally mounted in NEMA-1 enclosure.

C. Per requirements in Section 26 4300 – Surge Protective Devices

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, NEMA AB 3, UL 489; lockable handle; interrupting capacity to meet available fault current.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Fixed trip values for circuit breaker frame sizes 225 A and below.
   2. Electronic (solid-state microprocessor based) trip unit circuit breakers: digital true RMS sensing trip units; interchangeable in the field within the frame size (field-replaceable rating plug to determine the breaker trip rating), field-adjustable settings and the following trip functions for circuit breaker frame sizes 250 A - 1200 A:
      a. Instantaneous trip
      b. Long- and short-time pickup levels
      c. Long- and short-time time delay adjustments with I^2t response
      d. Ground-fault pickup level, time delay, and I^2t response
      e. Metering (where indicated on drawing)
   3. Current-Limiting Circuit Breakers: No fusible element, frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   4. 80% long time current rated

B. Molded-Case Circuit Breaker Options and Accessories: Standard frame sizes, trip ratings, and number of poles.
   1. Communication Capability: Trip unit mounted circuit breaker communication module with functions and features compatible with power monitoring system, specified in Section 26 2713 – Electrical Metering.

2. Undervoltage Trip: 120 V, set to operate at less than 75% of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
3. 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.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault protection function and/or short time function.

C. Enclosed, Insulated-Case Circuit Breaker and Accessories: NEMA AB 1, UL 489; fully rated circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed (individually) circuit breaker mounting for branch breakers
2. Drawout design: Circuit breaker to be withdrawn from an engaged position, to a test position, and to a disengaged position for main circuit breaker.
3. Two-step, stored-energy closing; manually operated.
4. A charging handle, closed pushbutton, open pushbutton and Off/On/Charge indicator located on the breaker escutcheon and visible with the breaker compartment closed.
5. Electronic (solid-state microprocessor-based) trip units with interchangeable rating plug, trip indicators, field-adjustable settings and the following trip functions:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time delay adjustments with I^2t response.
   d. Ground-fault pickup level, time delay, and I^2t response.
   e. Metering (where indicated on drawing)
6. Shunt Trip: 120 V trip coil energized from separate circuit.
7. Undervoltage Trip: 120 V, set to operate at 75% of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
8. 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.
9. Communication Capability: Trip unit mounted circuit breaker communication module with functions and features compatible with power monitoring system, specified in Section 26 2713 – Electrical Metering.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault protection function and/or short time function.
11. Listed for 100% of breaker’s continuous long time ampere rating.

D. Circuit Breaker Electronic Trip Units general characteristics:
1. Circuit breakers, with solid-state microprocessor based trip units:
   a. Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
   b. Trip units shall be removable to allow for field upgrades.
   c. Trip units shall incorporate “True RMS Sensing.”
2. Solid-state elements shall provide functions as indicated above.
3. Adjustments shall be made using non-removable, discrete steps.
4. Sealable transparent cover shall be provided over adjustments.
5. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL listed as field-replaceable. Adjustable rating plug shall allow for five minimum long-time

pickup settings from 0.4 to 1.0 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be at least three bands.

6. Short-time pickup shall allow for five minimum settings from 1.5 to 10 times Ir. Short-time delay shall be at least three bands with I^2t ON and OFF.
7. Instantaneous settings on the trip units shall be available in five minimum bands from 2 to 15 times In. The instantaneous settings shall also have an OFF setting when short-time pickup is provided.
8. Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one millisecond.
9. Trip unit shall indicate:
    a. Long-time fault
    b. Short-time fault
    c. Instantaneous fault
    d. Ground fault, where provided
    e. Metering (where indicated on drawing)
10. Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
11. Trip unit shall contain means to conduct circuit breaker test, or via separate test kit.
12. Breaker shall be equipped with externally accessible test points to be used for field testing.
13. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.
14. Trip units shall be provided with the following standard features:
    a. Power Trip Unit
    b. True RMS sensing
    c. LSI – Long-Time Pickup, Long-Time Delay, Short-Time Pickup, Short-Time Delay, Instantaneous
    d. LSIG/Ground-fault trip (where ground fault is required)
    e. Ground Fault Alarm (no trip), with external relay, where required
    f. Adjustable rating plugs
    g. LCD or LED – Long-time pickup
    h. LCD or LED – Trip indication
    i. Communications interface via ModBus TCP/IP
    j. LCD backlit display showing:
        1) Amperage per phase
        2) Voltage per phase
        3) Real Power Demand
        4) Apparent Power Demand
        5) Maximum peak power demand (measure of average power over a 15-minute period) continuously recorded over a one-year period
        6) Power Factor
    k. Contact wear indication

l. Incremental fine tuning of settings
m. Selectable long-time delay bands

E. Ground Fault protection equipment on breakers or relay for opening bolted pressure switches, where indicated: relay and trip unit, push-to-test feature and ground fault indicator:
1. Ground-fault protection with ten adjustable pick-up settings adjustable delay settings from 0 to.4 seconds. Arrange to provide protection for the following:
a. Three-wire or four wire or system
2. Trip units shall be capable of the following types of ground-fault protection: zero sequence.
3. Neutral current transformers shall be provided for 4-wire system.
4. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be in minimum three bands up to 1200 A.
5. Time delay is to have I^2T on and off functions.
6. Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.
7. Zone selective interlocking connections where main and branch devices in same switchboard require ground fault protection.

F. 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. Provision for Class L fuses
2. Fuses per requirements in Section 26 2813 – Fuses
3. Ground Fault Relay controlled releasing unit where required

G. Fused Switch: NEMA KS 1, UL 98; enclosed knife switch heavy duty type, external lockable operable handle, clips or pads to accommodate specified fuses:
1. Rejection clips for Class R fuses
2. Provision for Class J or RK1 fuses, as applicable
3. Fuses per requirements in Section 26 2813 – Fuses

2.8 CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer. Provide dual control power supplies for double-ended switchboards. Control power connections to the bus are to be on the line side of the main disconnecting device for each incoming source.

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 components mounted within assembly, such as relays, pushbuttons, switches, etc.: Suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for all control connections, except where saddle type terminals, integral to a

device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchboard, with wire markers at each end of control wiring.

E. Control power to supply individual circuit breaker trip unit. Coordinate supply voltage and current requirements with trip unit. No more than four (4) trip units are to be daisy chained together from the same source wiring and each vertical section is to have its own dedicated wiring back to control power source. For double ended systems, provide a minimum of two control power sources to supply the left and right halves of the switchboard. The tie breaker trip unit is to be connected to both power supplies.

F. Communications Gateway: Provide network switch and gateway to collect individual trip unit and meter network connections to allow for a single network connection to customer's LAN and/or BAS system. Coordinate requirements with LAN system administrator and BAS system provider. Gateway is to be powered from switchboard control power source. Gateways in double-ended switchboards are to be powered from both incoming source control power supplies.

2.9 ACCESSORY COMPONENTS AND FEATURES

A. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

C. Furnish set of tools for manually charging circuit breaker stored energy device.

2.10 CUSTOMER METERING

A. Per requirements in Section 26 2713 – Electrical Metering.

PART 3 - EXECUTION

3.1 COORDINATION

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:

1. Dimensions: Per requirements in Section 26 0529 – Hangers and Supports for Electrical Systems.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive switchboards for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchboard mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install switchboard in accordance with NEMA PB 2.1 and ANSI/NECA 400.

B. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification for each switchboard, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of each switchboard using self adhesive backing.

C. Provide metal manufacturer's nameplate indicating switchboard manufacturer's name and drawing number, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA 3-phase symmetrical) and momentary and fault-closing ratings (amp, RMS asymmetrical) and UL mark with applicable standard number. Permanently affix nameplate to switchboard main and tie sections with stainless steel rivets.

D. Provide framed, printed operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install switchboards in dedicated electrical space per NFPA 70, and as indicated on drawings.

F. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

G. Install fuses in fusible switch at job site per requirements in Section 26 2813 – Fuses.

H. Connect surge protective devices to switchboard bus per requirements in Section 26 4300 – Surge Protective Devices.

I. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

J. Apply temporary heat to prevent condensation according to manufacturer's written instructions.

3.4 CONNECTIONS

A. Ground switchboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect switchboards for physical damage, proper alignment, connections, anchorage, and grounding.

B. Test continuity of each circuit.

C. Test switchboards per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

E. Test switch operators after energizing.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings to values indicated on drawings or Overcurrent Protective Device Coordination Study.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner's personnel in the operation and maintenance of switchboards.

END OF SECTION

SECTION 26 2416.13

LIGHTING AND APPLIANCE PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0812 – Power Distribution Acceptance Tests

G. Section 26 0813 – Power Distribution Acceptance Test Tables

H. Section 26 2713 – Electrical Metering

I. Section 26 2813 – Fuses

J. Section 26 4300 – Surge Protective Devices

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes circuit breaker type lighting and appliance branch circuit panelboards as shown on drawings and as scheduled.

1.4 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA FU1 - Low-Voltage Cartridge Fuses

E. NEMA PB 1 - Panelboards

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

G. NFPA 70 - National Electrical Code

H. UL 50 - Enclosures for Electrical Equipment

I. UL 67 - Panelboards

J. UL 98 - Enclosed and Dead-Front Switches

K. UL 248 - Low-Voltage Fuses

L. UL 486A-486B - Wire Connectors

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

N. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

A. Product Data:
   1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.

B. Shop Drawings:
   1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
   2. Submit 1/4” scale electrical room floor plans with panelboard locations.

C. Partial Submittals:
   1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.

D. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

E. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Test Reports:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

G. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of panelboards and record actual circuiting arrangements.
   2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by single manufacturer.

B. Regulatory Requirements:
1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials:
1. Furnish Owner with two keys per panelboard.
2. Furnish 10% or minimum of three fuses of each rating and type of fuse installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. ABB - General Electric

C. Siemens

D. Cooper Bussman (Fusible and Elevator Panels Only)

E. Mersen (Fusible and Elevator Panels Only)

F. Littlefuse (Fusible Panels Only)

2.2 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. NEMA PB 1, UL 67

B. Fabrication:
1. Factory assembled.
2. With door-in-door construction.
3. Incoming feeder lugs: copper conductors.
4. Multiple lugs to match number of conductors per phase.
5. Sub-feed (double) lugs, or feed-through lugs where indicated.
6. Filler plates.
7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

C. Panelboard Buses:
1. Copper
2. Ampere rating as scheduled
3. Ground bus: uninsulated, bonded to panelboard cabinet
4. Insulated neutral bus: 100% of phase bus rating

D. Molded-Case Circuit Breakers:
1. NEMA AB 1, UL 489
2. Bolt-on type, labeled for 75°C copper and aluminum conductors
3. Quick-make, quick-break, with thermal-magnetic trip.
4. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
5. Ampere rating as scheduled
6. Listed as Type SWD for lighting circuits
7. Listed as Type HACR for air conditioning equipment circuits
8. Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
9. Tandem circuit breakers are not acceptable
10. Locks on trip handles where indicated
11. Main Circuit Breaker on all panelboards unless otherwise indicated on drawings.
12. Main breakers with shunt trip in branch circuit panels, where indicated
13. Ground fault equipment protection (GFEP), rated 30 mA trip, to provide equipment protection for branch circuits feeding electrical heat tracing, where indicated
14. Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated

E. Branch Fused Disconnects

1. Visible circuit ON/OFF indication with colored and international symbol markings.
2. Open fuse indication via permanently installed neon indicating light or permanent open fuse indication.
3. UL and cUL listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Finger-safe component with trim installed.
5. Mechanical interlock fuse and disconnect to prevent fuse removal while fuse terminals are energized.
6. No special tools required for fuse removal.
7. Bolt-on style bus connectors.
8. Clearly mark device housing with device amperage.
9. Provide permanently installed lockout means on the device for lockout tagout procedures. Provide permanently installed means for locking device in the ON position.
10. Provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A, 100A.

F. Main and Branch Fusible Overcurrent Protection
1. Overcurrent protective devices: minimum UL listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
2. Branch circuit overcurrent protection: 600Vac UL listed class CF minimum 300kA IR and CSA certified minimum 200kA IR finger-safe fuse.
3. Main overcurrent protective devices: 600Vac UL listed class CF or class J minimum 300kA IR and CSA certified minimum 200kA IR.
4. Panelboard main fuses: where installed, fused panelboard branch circuits shall selectively coordinate with upstream fuses for all overcurrents up to 200kA.

G. Cabinet
1. NEMA 250, UL 50
2. NEMA Type 1 enclosure.
3. Front (trim) surface mounted with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel.
7. Manufacturer’s standard gray enamel finish over prime coat.

2.3 METERS

A. Provide separate metering compartments with digital meter in accordance with Section 26 2713 - Electrical Metering.

2.4 SERVICE ENTRANCE

A. UL 869A

B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.5 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.6 SURGE PROTECTIVE DEVICES (SPD)

A. As indicated on drawings and as scheduled.

B. Per requirements in Section 26 4300 – Surge Protective Devices.

2.7 SPARE CONDUITS

A. Spare conduits per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required (i.e., top, bottom, right, left, or combination).

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting:
   1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
   2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
   3. Install two rows of steel slotted channel, with a minimum of 4 attachment points, for each panelboard section.
   4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6’-6” above finished floor or working platform with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A – 486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinator with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small metal screws or rivets. Do not use contact adhesive.
   1. Include panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

L. Install three 3/4” spare conduits stubbed into accessible ceiling space or space designated to be ceiling space in the future for all flush-mounted panelboards. Install conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

3.4 CONNECTIONS

A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Maintain proper phasing for multi-wire circuits.

C. Test main circuit breakers in accordance with requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

E. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energization of panelboards.

F. Check panelboards for electrical continuity of circuits and for short-circuits prior to energization.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

3.8 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION

SECTION 26 2416.16

DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

G. Section 26 2713 - Electrical Metering

H. Section 26 2813 – Fuses

I. Section 26 4300 – Surge Protective Devices

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes circuit breaker type and fusible switch type power distribution panelboards as shown on drawings and as scheduled.

1.4 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA FU 1 - Low-Voltage Cartridge Fuses

E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

F. NEMA PB 1 - Panelboards

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

H. NFPA 70 - National Electrical Code

I. UL 50 - Enclosures for Electrical Equipment

J. UL 67 - Panelboards

K. UL 486A – 486B - Wire Connectors

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

M. UL 4248 - Fuseholders

N. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

A. Product Data:
   1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.

B. Shop Drawings:
   1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker or fusible switch arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
   2. Submit 1/4” scale electrical room floor plans with panelboard locations.
   3. Submit features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   4. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.

C. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

D. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Report:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of panelboards and record actual circuiting arrangements.
   2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by a single manufacturer.

B. Regulatory Requirements:
1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials:
1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D – Schneider Electric

B. ABB - General Electric

C. Siemens

2.2 POWER DISTRIBUTION PANELBOARDS

A. NEMA PB 1, UL 67.

B. Fabrication:
   1. Factory assembled
   2. Individualized breaker or fusible switch dead-front cover door-in-door construction
   3. Incoming feeder lugs: copper conductors
   4. Multiple lugs to match number of conductors per phase
   5. Sub-feed (double) lugs, or feed-through lugs where indicated
   6. Filler plates
   7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

C. Panelboard Buses:
   1. Copper
   2. Ampere rating as scheduled
   3. Ground bus: uninsulated, bonded to panelboard cabinet
   4. Insulated neutral bus where applicable: 100% of phase bus rating

D. Molded-Case Circuit Breakers:
   1. NEMA AB 1, UL 489
   2. Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors
   3. Quick-make, quick-break, with thermal-magnetic trip and electronic (solid-state microprocessor-based) trip.
   4. Equipped with individually insulated, braced, and protected connectors
   5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
   6. Ampere rating as scheduled
   7. Front face flush with each other
   8. Large, permanent, individual circuit numbers affixed to each breaker in uniform position
   9. Tripped indication clearly shown by breaker handle taking position between “ON” and “OFF.”
   10. Listed as Type HACR for air conditioning equipment circuits
   11. Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
   12. For 225A frame size and below: thermal-magnetic trip
   13. For 250A frame size and above: electronic trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.
   14. Locks on trip handles where indicated

E. Fusible Switches:
   1. NEMA KS1, NEMA FU1, UL 512
   2. Labeled for 75°C conductors

3. Quick-make quick-break with visible blades, externally operable handle and dual horsepower ratings.
4. Handles to physically indicate “ON” and “OFF” position.
5. Lockable only in “OFF” position and accept three industrial type heavy-duty padlocks.
6. Covers and handles be interlocked to prevent opening in “ON” position, with means to permit release of interlock.
7. Large permanent individual circuit numbers affixed to each fusible switch in uniform position.
8. Rejection clips for Class R fuses specified.
9. Provisions for Class J or Class L fuses, as applicable.
10. Fuses: Per requirements in Section 26 2813 – Fuses.

F. Cabinet
1. NEMA 250, UL 50
2. NEMA Type 1 enclosure.
3. Four-piece front (trim) surface mounted with door over the front, with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch except omit door in fusible switch panelboard.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel
7. Manufacturer’s standard gray enamel finish over prime coat

2.3 METERS

A. Provide separate metering compartments with digital meter in accordance with Section 26 2713 - Electrical Metering.

2.4 SERVICE ENTRANCE

A. UL 869A

B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.5 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.6 SURGE PROTECTIVE DEVICES (SPD)]

A. As indicated on drawings and as scheduled.

B. Per requirements in Section 26 4300 – Surge Protective Devices.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required, i.e. top, bottom, right, left, or combination.

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting:
   1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
   2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
   3. Install two rows of steel slotted channel, with a minimum of four attachment points, for each panelboard section.
   4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6’-6” above finished floor or working platform, with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A –486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads before completing load balancing) mounted inside each panelboard door. Include description of

connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinate with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.
   1. Indicate panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

L. Install fuses in fusible switches, per requirements in Section 26 2813 – Fuses.

3.4 CONNECTIONS

A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Test circuit breakers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energizing panelboards.

E. Check panelboards for electrical continuity of circuits and for short-circuits prior to energizing.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint to Owner.

3.7 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

B. Circuit Breakers: Set field-adjustable trip settings or change the trip settings, as provided by engineer.

3.8 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION

SECTION 26 2500

ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0593 – Electrical Systems Firestopping

G. Section 26 0812 – Power Distribution Acceptance Tests

H. Section 26 0813 – Power Distribution Acceptance Test Tables

I. Section 26 2813 – Fuses

J. Section 26 2816 – Enclosed Switches and Circuit Breakers

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes feeder and plug-in busways, 600 V or less, including accessories, plug-in units and components.

1.4 REFERENCE STANDARDS

A. NEMA BU 1 – Busways

B. NEMA BU 1.1 – General Instructions for Handling, Installation, Operation and Maintenance of Busways Rated 600V or Less

C. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. UL 98 – Enclosed and Dead-Front Switches

F. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breakers Enclosures

G. NFPA 70 – National Electrical Code

1.5 SUBMITTALS

A. Product Data:
   1. Submit catalog cuts for components, accessories, and plug-in units.

B. Shop Drawings:
   1. Submit for review for each type of busway and plug-in unit.
   2. Indicate ratings, dimensions, layout diagram, and finishes.
   3. Show fabrication and installation details.
   4. Indicate location of supports and fittings.
   5. Indicate listed firestops and weatherseals at penetrations; show fittings, materials, fabrication, and installation methods.
   6. Include details of wall and floor penetrations.
   7. Indicate required clearances, method of field assembly, and location and size of each field connection.
   8. Indicate short circuit current rating.

C. Coordination Drawings: Floor plans and section (where needed), drawn to scale. Include completely dimensioned and scaled busway layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:
   1. Vertical and horizontal enclosed busway runs, offsets, and transitions.
   2. Clearances for access above and to the side of enclosed busways.
   3. Vertical elevation of enclosed busways above the floor or bottom of structure.
   4. Support locations, type of support, and weight on each support.

D. Location of adjacent construction elements, including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

E. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

G. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of busway routing and location of plug-in units.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain busways, fittings, accessories and plug-in units from one source and by single manufacturer.

B. Regulatory Requirements:
1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA BU 1.1 and manufacturer's written instructions.

1.8 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

1.9 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.10 MAINTENANCE

A. Extra Materials:
1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Feeder and plug-in busways and plug-in units:
1. Square D – Schneider Electric
2. ABB - General Electric
3. Siemens

B. Busway shall be of the same manufacture as the electrical equipment busway terminates in or originates from, except for automatic transfer switches as noted below.

1. Busway system manufacturer shall furnish termination fittings to manufacturer of automatic transfer switches for factory installation.

2.2 FEEDER AND PLUG-IN BUSWAYS

A. Description: NEMA BU 1, low-impedance busway in non-ventilated housing:
   1. Voltage and ampere ratings as indicated.
   2. 100% neutral capacity.
   3. Ground bus: **50% capacity integral with housing.**
   4. Temperature Rise: 55°C above 40°C ambient maximum for continuous rated current.
   5. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation, except at joints.
   6. Joints: Single bolt type, with silver-plated contact surface for bus and split plate, testing of tightness and inspection without de-energizing, removal of any one section without disturbing adjacent pieces.
   7. Standard 10 ft sections.
   8. Feeder busway enclosure: Weatherproof, galvanized steel or aluminum with manufacturer's standard finish, sealed seams, drains, and removable closures.
   9. Plug-in busway enclosure: Steel, with manufacturer's standard finish, plug-in openings 24" o.c., and hinged covers over unused openings
   10. Fittings and Accessories: Manufacturer's standard.
   11. Mounting: Arranged flat, edgewise, or vertically without derating.

2.3 **PLUG-IN UNITS**

A. Description: Switching and overcurrent protection in enclosure with hinged door and externally operable handle for (hookstick) (chain) operation:
   1. Types and ratings as indicated.
   2. Mechanically interlocked with bus housing to prevent installation or removal while in ON position; means to defeat interlock.
   3. Ground connection to housing before stabs make contact with busbars.
   4. Provisions for 10 plug-in openings, per 10 ft section, 5 to a side and usable simultaneously.
   5. Suitable support at each plug-in opening for protection of bus in event of stresses due to fault.
   6. Full isolation of stabs of any plug-in device installed on busway.
   7. Molded-Case Circuit Breakers: NEMA AB 1 and UL 489; quick-make, quick-break, with [thermal-magnetic trip] [electronic (solid-state microprocessor-based) trip]; lockable with two padlocks, and interlocked with cover in closed position:
      a. For 225A frame size and below: thermal-magnetic trip.
      b. For 250A frame size and above: electronic trip units interchangeable in the field within the frame size and field-adjustable [long time pick-up], [long time delay], [short time pick-up], [short time delay], and [instantaneous] current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.
   8. Fusible Switches: NEMA KS 1 and UL 98; enclosed knife switch, heavy-duty type, externally operable handle, lockable with two padlocks, and interlocked with cover in closed position; clips or pads to accommodate specified fuses:
      a. Rejection clips for Class R fuses.

b. Provisions for Class J or Class L fuses, as applicable.
c. Fuses: Per requirements in Section 26 2813 - Fuses.

2.4 SHORT CIRCUIT CURRENT RATING

A. Busways and plug-in units with minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.1 FIELD COORDINATION

A. Coordinate busways routing to clear work of other trades:
1. Coordinate with installation of adjacent construction elements, including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
2. Coordinate relationship between busways and adjacent structural, mechanical, and electrical elements.
3. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement and formwork shall conform to requirements in Division 03. Refer to details shown on drawings.

B. Coordinate factory installation of termination fittings furnished by busway system manufacturer with the manufacturer of electrical equipment.

C. Coordinate busway terminations to equipment enclosures to ensure proper phasing, connections, and closure.

D. Verify field measurements prior to fabrication.

E. Coordinate the precise length of vertical busways so that joints and other components requiring access occur in accessible areas (ceiling space above finished area or equipment rooms). Access panels in finished walls are not acceptable, except where indicated.

F. Coordinate floor penetrations.

G. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

H. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 INSTALLATION

A. Install in accordance with NEMA BU 1.1, parallel to walls, floors, and ceilings.

B. Tighten buses’ joints using torque wrench, to manufacturer’s specified values.

C. Install busway length with expansion fitting at each location where busway run crosses building expansion joint. Install expansion fittings per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

D. Mount horizontal busway runs in edgewise to allow access to tap locations on both sides.

E. Busway supports:
   1. Support busway to prevent twisting from eccentric loading.
   2. Support busways at maximum as recommended by manufacturer or at 10’ intervals. Do not block access to busway joint with supports or hardware.
   3. Support busway by steel slotted channel with 3/8” minimum steel threaded hanger rods. Install side bracing to prevent swaying or movement of busway, for unbalanced weight of busway with plug-in units plus weight of a 250 lb man on a ladder at the height of the busway installation.
   4. Support vertical risers at each floor level by adjustable vertical spring hangers as indicated on drawings.
   5. Fasten supports securely to building structure according to Section 26 0529 – Hangers and Supports for Electrical Systems.

F. Install busway with integral firestops located where busway penetrates fire-rated walls, ceilings, and floors. Seal around opening to maintain fire rating equal to wall, ceiling, or floor rating. Refer to requirements in Section 26 0593 – Electrical Systems Firestopping.

G. Install concrete curb at least 4” high around interior floor penetrations.

H. Install busway with integral weatherseal fittings and flanges located where busway penetrates exterior wall or roof. Seal around opening to maintain weathertight installation.

I. Install fuses in fusible switches at job site per requirements in Section 26 2813 – Fuses.

J. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplates to busway using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.
   1. Indicate busway name, amperage, voltage, phase, number of wires and short circuit rating.

K. Do not block plug-in openings by hangers.

L. Install plug-in units. Support connecting conduit independent of plug-in unit.

M. Install flexible liquid-tight metal conduit connection to plug-in units to permit removal. Provide conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.4 FIELD QUALITY CONTROL

A. Inspect busways for physical damage, proper alignment, supports, and seismic restraints.

B. Inspect busway components, wiring, connections, and grounding.

C. Test busways per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Remove and replace plug-in units that do not pass tests and inspections and retest.

E. Interpret test results in writing and submit to Engineer.

F. Meggar test busways immediately prior to energizing, interpret test results in writing and submit to Engineer.

G. Scan entire busway with infra-red thermography camera with bus energized and loaded to at least 50% rated ampacity. Provide load bank to supplement load if required. Provide test results to Engineer. Make corrections to busway joints and components that show abnormal heating and retest.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 ADJUSTING

A. Set field adjustable circuit breaker trip settings or change the trip settings, as indicated on drawings.

3.7 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.8 PROTECTION

A. Provide final protection to ensure that moisture does not enter busways.

END OF SECTION

SECTION 26 2550

GENERATOR DOCKING STATION

PART 1 GENERAL

1.1 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.

GUARANTEE/WARRANTY

A. Refer to Section 01 77 19 – Contract Closeout and Section 26 00 00 – General Electrical Requirements for general warranty requirements.

B. The equipment installed under this contract shall be left in proper working order.

C. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

COMMISSIONING

A. An independent third-party Commissioning Agent will document completion of the Fire Suppression, Mechanical, Plumbing, HVAC, Electrical and Electronic Safety and Security Systems for the project. The Construction Manager and Division Subcontractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 01 91 13 “Building Systems Commissioning” for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team

OPERATION AND MAINTENANCE MANUAL

A. Refer to Division 01 Section 01 78 23 for requirements
   1. O&M manuals
   2. Training log and Training hours required for each piece of equipment

CONTRACT CLOSE OUT

A. Refer to Division 01 Section 01 77 19 for requirements
   3. Spare parts
   4. As- Built
   5. Warranty

PART 2 PRODUCTS

2.1 GENERATOR DOCKING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   6. Trystar
   7. Gus Berthold Electric
   8. ESL Power Systems

2.2 GENERAL REQUIREMENTS

A. Docking station shall include 16 Series Camlok Panel Mounts for use as connection to Portable Load Bank.

B. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

C. Enclosures:
   1. NEMA 3R 12ga Steel or Aluminum enclosure

a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA 3R integrity shall be maintained with access plate open for cable entry.
b. Front and side through a front access panel shall be accessible for maintenance.
c. Top, side, and bottom through a front access panel shall be accessible for permanent cabling.

2. Finishes:
a. Paint after fabrication.

D. Phase, Neutral, and Ground Buses:
1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.

E. Temporary load bank connectors shall be Camlok style mounted on gland plate.
1. Camlok shall be color coded according to system voltage
a. A phase –Brown
b. B phase –Orange
c. C phase –Yellow
d. G Ground – Green

F. Temporary connectors shall include protective flip lids to prevent accidental contact.

G. Permanent connectors shall be compression lug.

H. Voltage presence indicator mounted to front door.

I. Short Circuit & Withstand Rating
1. Shall be minimum 100KAIC unless otherwise indicated on drawings.

J. Voltage & Amperage:
1. 480V, 3-Phase, 4W, 3000A

K. Phase Rotation Monitor Device:
1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal.

L. Additional accessories shall be included in submittal drawings as follows:
1. Two Wire Auto Start

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Surface, Flush or Base Mounted: Determined by Application
1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.3 FIELD QUALITY CONTROL

A. Third Party Tests and Inspections to include the following:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 25 50

SECTION 26 2713

ELECTRICAL METERING

PART 1 - GENERAL

1.1 RELATED WORK

A. [Section 23 0901 – Control Systems Integration

B. Section 23 0905 – Instrument Point List

C. Section 23 0993 – Control Sequences]

D. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

E. Section 26 0526 – Grounding and Bonding for Electrical Systems

F. Section 26 0529 – Hangers and Supports for Electrical Systems

G. Section 26 0548 – Vibration and Seismic Controls for Electrical Systems

H. Section 26 0553 – Electrical Systems Identification

I. Section 26 0812 – Power Distribution Acceptance Tests

J. Section 26 0813 – Power Distribution Acceptance Test Tables

K. Section 26 0913 – Electrical Power Monitoring and Control

L. Section 26 1113 – Primary Unit Substations

M. Section 26 1316 – Medium-Voltage Fusible Interrupter Switchgear

N. Section 26 2300 – Low-Voltage Switchgear

O. Section 26 2313 – Paralleling Low-Voltage Switchgear

P. Section 26 2413 – Switchboards

Q. Section 26 2416.13 – Lighting and Appliance Panelboards

R. Section 26 2416.16 - Distribution Panelboards

S. Section 26 2813 – Fuses

T. Section 26 4300 – Surge Protective Devices

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes equipment for energy and demand metering by Owner. It also includes options that provide for monitoring or automatic control of demand at a remote location.

1.4 REFERENCE STANDARDS

A. ANSI C12.1 – Code for Electricity Metering

B. ANSI C12.7 – Requirements For Watthour Meter Sockets

C. ANSI C12.9 – Test Switches For Transformer-Rated Meters

D. ANSI C12.10 – Watthour Meters

E. ANSI C12.11 – Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV Through 69 kV NSV)

F. ANSI C12.18 – Protocol Specification For ANSI Type 2 Optical Port

G. ANSI C12.19 – Utility Industry End Device Data Tables

H. ANSI C12.20 – Electricity Meters-0.2 and 0.5 Accuracy Classes

I. ANSI C39.1 – Requirements, Electrical Analog Indicating Instruments

J. IEEE C37.90.1 – Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

K. IEEE C57.13 – Standard Requirements for Instrument Transformers

L. IEEE C62.11 – Metal-Oxide Surge Arresters for Alternating Current Power Circuits

M. IEEE C62.41.1 – Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits

N. IEEE C62.41.2 – Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

O. IEEE C62.45 – Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

P. NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

Q. NECA 400 – Recommended Practice for Installing and Maintaining Switchboards

R. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

S. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

T. NEMA AB 3 – Molded-Case Circuit Breakers and Their Applications

U. NEMA EI 21.1 – Instrument Transformers for Revenue Metering (110KV BIL and Less)

V. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

W. NEMA LA 1 – Surge Arresters

X. NEMA PB 2 – Dead-Front Distribution Switchboard

Y. NFPA 70 – National Electrical Code

Z. UL 50 – Standard for Enclosures for Electrical Equipment (1995)

AA. UL 98 – Enclosed and Dead-Front Switches

BB. UL 414 – Standard for Meter Sockets (1999)

CC. UL 467 – Grounding and Bonding Equipment

DD. UL 486A-486B – Wire Connectors

EE. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

FF. UL 891 – Dead-Front Switchboards

GG. ASTM D1535 – Standard Practice for Specifying Color by the Munsell System

1.5 SUBMITTALS

A. Product Data: For metering equipment, components and accessories indicated:
   1. Include data on features, components, and complete description; submit catalog cut sheets showing electrical characteristics and ratings.
   2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe operating sequences, both automatic and manual.

B. Shop Drawings:
   1. Dimensioned plans and sections or elevation layouts.
   2. Wiring Diagrams: Power, signal, and control wiring. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field installed wiring, and show circuit protection features.

C. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations and ratings of metering equipment on single-line diagrams and plan layouts.
   2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include manufacturer's written instructions for testing.
c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
d. Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.6 QUALITY ASSURANCE

A. Obtain metering equipment from one source and by single manufacturer.

B. Regulatory Requirements:
1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
3. Products being used as part of a utility or revenue metering system must meet the requirements of the electrical utility.

1.7 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
1. Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.
2. Control-Power Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.
3. Fuses for Fused Switches: Equal to 10% of amount installed for each size and type, minimum of 3 of each size and type.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICAL METERING BY OWNER

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Manufacturers – Models:
a. Panelboard/Switchboard/Switchgear:
1) Schneider Electric PowerLogic METSEPM5563RD
2) Eaton PXM2260MA65145

b. LEED Multi-Circuit Meter
    1) Schneider Electric PowerLogic HDPM6000

2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    a. Phase Currents, Each Phase: +/-0.5%
    b. Phase-to-Phase Voltages, Three Phase: +/-1%
    c. Phase-to-Neutral Voltages, Three Phase: +/-1%
    d. Kilowatts: +/-2%
    e. Kilovars: +/-2%
    f. Power Factor: +/-2%
    g. Frequency: +/-0.5%
    h. Megawatt Demand: +/-2%; demand interval programmable from 5 to 60 minutes
    i. Accumulated Energy, Megawatt Hours: +/-2%. Accumulated values unaffected by power outages up to 72 hours
    j. Maximum demand (measure of average power demand over a 15-minute period) continuously recorded over a one-year period.
    k. Total Harmonic Current Distortion, Percentage
    l. Total Harmonic Voltage Distortion, Percentage
    m. Individual Current Harmonics through the 63rd
    n. Integral Communications Port
3. Mounting: Display and control unit flush or semiflush, mounted in instrument compartment door.

B. Instrumentation:
1. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
    a. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
        1) 600 V and below: external PTs not required; fused potential connection.
    b. Current Transformers: Window type; ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments; shorting test blocks: 10 poles – 4 potential and 6 current, mounted with meter or in accessible location.
    c. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
    d. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker ground-fault protection.

C. Data Communications:
1. Means to transmit data to central control and/or monitoring system.
    a. Two RS 485 communication ports.
    b. Output communication of the meter through a serial RJ-45 connection.
    c. Provide meter gateway for connecting two or more meters within the same piece of equipment.
    d. Digital communication port connection in BACnet compatible communication protocol to communicate with Building Automation System (BAS) via Ethernet.

e. Keypad and scrollable display for local reading of measured values.

D. Kilowatt-Hour Meters:
1. Manufacturers:
a. Schneider Electric PowerLogic METSEPM5563RD
b. Eaton PXM2260MA65145
2. Kilowatt-Hour/Demand Meter: Electronic single and/or three-phase meters, measuring electricity use and demand.
a. Voltage and Phase Configuration: Designed for use on circuits with voltage rating and phase configuration indicated for its application.
b. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
c. Demand Signal Communication Interface: Match signal to building automation system or campus standard input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
d. Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.
e. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
f. Identification: Comply with Section 26 0553 – Electrical Systems Identification.
g. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
h. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.
1) Type: Split core.
i. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.
j. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate adjustment and programming of metering equipment with manufacturer.

B. Instruct manufacturer about the location of incoming lugs (i.e., top or bottom feed based on incoming feeder entrance location).

C. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:
1. Concrete: Per requirements in Division 03 – Concrete.
2. Dimensions: Per requirements in Section 26 0529 – Hangers and Supports for Electrical Systems.

D. Coordinate with miscellaneous trades for equipment foreign to electrical installation to be outside of dedicated electrical space.

E. Verify with manufacturer that “touch-up” paint kit is available for repainting.

F. Coordinate utility company metering equipment requirements.

G. Coordinate meter data transmission with campus Tridium Building Automation System (BAS) and campus power monitoring system (CPMS) to integrate metering components with system architecture.
   1. Each meter shall transmit data independently, daisy chaining of meters for communication to Tridium Building Automation System (BAS) is not acceptable.

H. Coordinate meter data transmission with Tridium Building Automation System (BAS) to integrate electrical system metering data with campus power monitoring system (CPMS) and Tridium Building Automation System (BAS) GUI and LEED reporting requirements.

3.2 EXAMINATION

A. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Comply with installation requirements in NECA 1.

B. Tighten electrical connectors and terminal according to equipment manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

C. Install fuses in fusible switch at job site per requirements in Section 26 2813 – Fuses.

D. Install surge arrestors in cable termination compartments and connect to each phase of circuit, per requirements in Section 26 4300 – Surge Protective Devices.

E. Mount meters in the locations indicated on the drawings. Mounting height: 5’-6” or less from finished floor.

3.4 FIELD WIRING

A. Install field wiring to complete the electricity metering installation.
   1. Transformer-rated meter:
      a. Current transformer wiring shall be #12 AWG minimum size. Where distance to meter exceeds 22 ft, increase wire size to #10 AWG to reduce the burden on the metering circuit.
      b. Potential wiring shall be #14 AWG.
      c. Color coding: Same for current and potential wiring. A phase – black; B phase – red; C phase – blue; Neutral – white; Ground – green. Identify all wiring with plastic sleeve wire markers. Cloth markers are not acceptable.
      d. Neatly train and lace wiring for metering installation within pad-mounted transformer compartment and meter socket enclosure using nylon cable ties.
   2. Self-contained meter:
      a. Field wiring for building automation system (BAS) connection to solid-state electricity meter:

1) Conduit: Install a 3/4” conduit routed underground from meter compartment to BAS panel in the building; terminate conduit within 12” of BAS panel.
2) Communications Wiring: In the 3/4” conduit, install a 3-conductor communications cable as recommended by meter manufacturer. Connect one end to cable lead from meter KYZ pulse initiator module. Leave 4 ft excess cable coiled at opposite end for connection to BAS panel.

3.5 CONNECTIONS

A. Ground metering equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.6 FIELD QUALITY CONTROL

A. Test continuity of each circuit.

B. Test metering equipment per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Test Owner’s electricity-metering installation for proper operation, accuracy, and usability of output data.
   1. Connect a load of known kilowatt rating, 2kW minimum, to a circuit supplied by metered feeder.
   2. Turn off circuits supplied by metered feeder and secure them in off condition.
   3. Run test load continuously for 8 h, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
   4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
   5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

E. Inspect modular meter center for physical damage, proper alignment, connections, anchorage, and grounding.

F. Verify that correct multiplier is indicated on face of meter.

G. Verify that current transformer secondary circuits are intact.

H. Inspect indicating devices for proper operation.

3.7 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.8 ADJUSTING

A. Adjustment and programming of metering equipment: By factory-authorized representative.

B. Compare meter display readings with readings taken with clamp on ammeter and hand held voltmeter.

C. Make adjustments as necessary.

3.9 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.10 DEMONSTRATION

A. Provide training session by manufacturer for up to 4 h at a job location, to train the Owner's personnel in the operation and maintenance of metering equipment.

END OF SECTION

SECTION 26 2726

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 - Grounding and Bonding for Electrical Systems

B. Section 26 0553 - Electrical Systems Identification

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes receptacles, hazardous (classified) location receptacles and device cover plates.

1.4 REFERENCE STANDARDS

A. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

B. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits

C. IEEE C62.45 – Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits

D. NECA 1 – Good Workmanship in Electrical Contracting

E. NFPA 70 – National Electrical Code

F. ~~[~~NFPA 99 –Health Care Facilities~~]~~

G. NEMA WD-1 – General Color Requirements for Wiring Devices

H. NEMA WD-6 – Wiring Devices - Dimensional Requirements

I. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

J. UL 498 – Attachment Plugs and Receptacles

K. UL 943 – Ground-Fault Circuit-Interrupters

L. UL 1310 – Class II Power Units

M. UL 1436 – Outlet Circuit Testers and Similar Indicating Devices

N. ~~[~~UL 1449 – ~~Transient Voltage Surge Suppressors~~Surge Protective Devices~~]~~

O. [UL 1699A – Arc Fault Circuit Interrupters]

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations and ratings of wiring devices.
   2. Operation and Maintenance Data:
      a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
      b. Include source and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain wiring devices from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Wiring Devices; a division of Cooper Industries, Inc.

B. Hubbell Incorporated; Wiring Device-Kellems

C. Leviton Manufacturing Company, Inc.

D. Pass & Seymour/Legrand; Wiring Devices & Accessories

2.2 RECEPTACLES

A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Receptacles: 125 V, 20A, ~~[heavy-duty (specification grade)]~~ ~~[~~hospital grade~~]~~; back and side wired; flush or surface mounted; straight blade; 2 pole, 3 wire grounding; thermoplastic body; duplex configuration unless otherwise noted. *All receptacles in project shall be Tamper Resistant (TR) type.*

1. Ground Fault Circuit Interrupter (GFCI):
   a. Additional compliance with UL 943 Class A.
   b. Leakage current trip level: 4 to 6 mA.
   c. Trip time: .025 seconds nominal.
   d. Feed-through type
   e. Reverse line-load function to prevent GFCI from functioning if wired incorrectly.
   f. Indicator Light: Lighted when device is tripped.
2. Isolated Ground (IG):
   a. Ground strap isolated from mounting strap.
   b. Ground screw connected directly to ground contacts.
3. ~~[~~USB Charging:
   a. UL-498 and UL-1310 listed
   b. Two USB 2.1 Amp or 3.0 Amp, 5VDC charging ports in addition to two 120V, 20A NEMA 5-20R outlets in one single gang device.
      1) One USB Type-A port
      2) One USB Type-C port
   c. LED indicator for notification of USB port connection.
   d. Auto-grounding connection type.~~]~~
4. ~~[~~Arc Fault Interrupter (AFCI):
   a. Additional compliance with UL 1699A
   b. Face-mounted test and reset actuation.
   c. Face-mounted LED indicating unit is powered and functioning.
   d. Tamper resistant (TR).~~]~~
5. ~~[Transient Voltage Surge Suppression~~Surge Protective Device (~~TVS~~SPD):
   a. Additional compliance with UL 1449, with integral ~~TVSS~~ SPD in line to ground, line to neutral, and neutral to ground.
   b. ~~TVSS~~ SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   c. Active ~~TVSS~~ SPD Indication: Visual and audible, with light visible in face of device to indicate devise is “active” or “no longer in service.”~~]~~

6. Tamper Resistant (TR):
   a. Requires insertion of object in both left and right contacts to energize.
   b. 2- or 3-prong plug.
7. Twist-locking:
   a. NEMA WD 6 configuration as indicated on drawings.
8. Switched: Upper half switched and lower half not switched.
9. Dedicated: Labeled “Dedicated.”
10. Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.

2.3 DEVICE COVER PLATES

A. Single and combination types to match corresponding wiring devices:
   1. Attachment: Metal screws with head color to match plate finish.
   2. Material for Finished Spaces:
      a. Satin-finished stainless steel.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Cast aluminum with while-in-use hinged cover, and listed and labeled for use in “wet locations.”

B. Weatherproof Cover Plates (Indoor Flush):
   1. Vertical Receptacles: Hubbell HBL5221 or approved equal.
   2. Horizontal Receptacles: Hubbell HBL5206WO or approved equal.

C. Weatherproof Cover Plates (Outdoor): NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with weatherproof while-in-use hinged cover with tab for locking with padlock.

D. Tamper Resistant (TR):
   1. Slide cover over receptacle.

2.4 FINISHES

A. Color:
   1. Receptacle faceplates, and device cover plates: ~~insert color~~WHITE, except as follows:
      a. Receptacle faceplates connected to Essential Power System: Red.
      b. ~~[~~TVSS SPD Receptacles: Blue~~]~~
      ~~c. [Isolated-Ground Receptacles: As specified above, with orange triangle on face.]~~
      ~~d. [UPS Receptacles: Gray]~~

PART 3 - EXECUTION

3.1 COORDINATION

A. Special Purpose Receptacles: Coordinate final selections of NEMA configuration (locking, straight, blade, etc.) with configuration of plug on utilization equipment.

B. Receptacles for Owner-furnished equipment and equipment furnished under other divisions of specifications: Match plug configurations.

C. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers guided by riding against outside of the 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 device cover plate does not cross a joint
   4. Install wiring devices after all wall preparation, excluding painting, is complete. Install device cover plates after painting is complete.

3.2 EXAMINATION

A. Verify location of wiring devices with architectural interior elevation drawings, prior to rough-in.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

A. Clean debris from outlet boxes.

3.4 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise scheduled or indicated on drawings. Indicated dimensions are to center of device.

B. Conductors:
   1. Do not strip insulation from conductors until just 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. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Do not place bare stranded conductors directly under device screws. Use crimp on fork terminals for device terminations.

C. Device Installation:
   1. Replace all devices that have been in temporary use during construction or show signs of installation prior to completion of building finishing operations.
   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 last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6” in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than #10 AWG are installed on 20A circuits, splice #12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install devices plumb, level with finished surfaces and free from blemishes.
11. Install devices above counters, 2” to the bottom of device above countertop or backsplash. Install all devices at same height above any one counter or fixed cabinet.
12. Install special purpose receptacles according to shop and rough-in drawings furnished by trade(s) producing such equipment. Verify locations prior to rough-in.
13. Install weatherproof GFCI receptacles:
    a. Within 25’-0” of roof-mounted mechanical equipment
    b. Outdoors
    c. As indicated on drawings
14. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Ground per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

D. Installation Orientations:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Unless otherwise indicated or where space problem occurs, mount devices flush, with long dimension vertical.

E. Device Cover 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.

3.5 IDENTIFICATION

A. Comply with Section 26 0553 – Electrical Systems Identification.
1. Receptacles (20A, 120V): Use hot, stamped or engraved machine printing with black-filled lettering on white background on face of cover plate, and durable wire markers or tags inside outlet boxes. Indicate source panel identification and circuit number. Indicate “NORMAL” on side of receptacle opposite of panel/circuit.
2. Receptacles (other than 20A,120V): Use hot, stamped or engraved machine printing with black-filled lettering on white background on face of cover plate, and durable wire markers or tags inside outlet boxes. Indicate source panel identification, circuit number, voltage, phase, and amperage.
3. [Essential Power Receptacles: In addition to above, identify coverplates with engraved “EMERGENCY” or “CRITICAL” depending on classification of system.]
4. Engrave cover plates on all Owner-furnished equipment and equipment furnished under other divisions of these specifications with source panel identification, circuit number (where applicable) as specified in this section. [This includes headwalls, gas columns and booms,

patient consoles, medical rail systems, custom casework with electrical devices, etc. Include "Emergency", "Critical" or "Standby" as required depending on classification of system.]

3.6 FIELD QUALITY CONTROL

A. Inspect wiring devices for defects.

B. Verify receptacle device is energized.

C. Perform tests and prepare test reports:

1. Test receptacle devices for proper polarity:
   a. Test every receptacle with receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.
2. Test each GFCI receptacle device for proper operation:
   a. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. "TEST" button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power with 5/1000 A within 1/40 second and retest.
3. [Test each AFCI device for proper operation:
   a. Perform testing using an instrument specifically designed and manufactured for testing arc-fault circuit interrupters. Apply the test to the receptacle. "TEST" button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power within the limits stated in UL-1699A and retest.]
4. [In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.]
5. Test Instruments: Use instruments that comply with UL 1436.
6. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

D. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 V to 132 V.
2. [USB Voltage: Acceptable range is 4.8VDC to 5.5VDC.]
3. Percent Voltage Drop under 15A Load: A value of 5% or higher is not acceptable.
4. Ground Impedance: Values of up to 2 ohms are acceptable.
5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
6. [AFCI Trip: Test for tripping values specified in UL 1699A.]
7. Using the test plug, verify that the device and its outlet box are securely mounted.
8. The 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.

E. Test straight blade [convenience outlets in patient-care areas] [hospital-grade convenience outlets] for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

F. Operational Tests: Demonstrate the operation of each switch with the systems fully energized and operating. Each switch shall be demonstrated three times.

G. Interpret test results in writing and submit to Engineer.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

A. Remove excess plaster from interior of outlet boxes.

B. Clean devices and cover plates after painting is complete. Replace stained or improperly painted devices and cover plates.

END OF SECTION

SECTION 26 2813

FUSES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 2413 – Switchboards

B. Section 26 2416.16 - Distribution Panelboards

C. Section 26 2419 - Motor Control Centers

D. Section 26 2816 - Enclosed Switches and Circuit Breakers

E. Section 26 2913 - Enclosed Controllers

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and section under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes nonrenewable cartridge fuses, rated 600V and less, for use in low-voltage power distribution system and spare fuse cabinet.

1.4 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses

B. UL 248-1 - Low Voltage Fuses - Part 1: General Requirements

C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses

D. UL 248-5 - Low-Voltage Fuses - Part 5: Class G Fuses

E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses

F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses

G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses

H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses

I. UL 248-17 – Low-Voltage Fuses – Part 17: Class CF Fuses

J. UL 4248 - Fuseholders

1.5 SUBMITTALS

A. Product Data:

1. Submit the following for each fuse type and size indicated:
   a. Manufacturer's technical data on features, performance, electrical characteristics, ratings, and dimensions.
   b. Time-current curves, selective coordination charts and tables, and related data.
   c. Let-through current curves for fuses with current-limiting characteristics.
   d. Fuse size for each elevator disconnect switch.

B. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual class, size, and location of fuses.

1.6 QUALITY ASSURANCE

A. Obtain fuses from one source and by single manufacturer.

B. Comply with NFPA 70 for components and installation.

1.7 MAINTENANCE

A. Extra Materials:
   1. Furnish to the Owner a quantity of spare fuses equal to 10% of the total quantity of each fuse class and size installed, minimum of 3 of each fuse class and size.
   2. Furnish 2 fuse pullers for each size fuse.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton Cooper Bussmann

B. Mersen

C. Littelfuse

2.2 CARTRIDGE FUSES

A. NEMA FU 1, UL 248-1.

B. Characteristics: nonrenewable current-limiting cartridge fuse; current rating and class, as specified or indicated, and voltage rating consistent with circuit voltage.

C. Miscellaneous data:

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-4	CC	600	0-30	200,000
248-5	G	600	0-20	100,000
248-5	G	480	25-60	100,000

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-8	J	600	0-600	200,000
248-10	L	600	601-6000	200,000
248-11	Plug	125	15-30	10,000
248-12	RK1	250 or 600	0-600	200,000
248-12	RK5	250 or 600	0-600	200,000
248-15	T	300	0-1200	200,000
248-15	T	600	0-800	200,000
248-17	CF	600	1-100	200,000

2.3 FUSEBLOCKS

A. UL 4248

B. Thermoplastic base with UL flammability 94VO

C. Clip reinforcing springs – 100A and above

D. 200,000 A RMS Sym short-circuit current rating

E. Copper or aluminum connections

2.4 FINGER SAFE FUSEHOLDERS

A. UL 4248

B. Thermoplastic base with UL flammability 94VO

C. Cover over fuses

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

3.2 INSTALLATION

A. Verify proper fuse locations, sizes, and characteristics.

B. Install fuses in fusible devices specified in other sections at job site.

C. Arrange fuses so manufacturer, class, and size are readable without removing fuse.

D. Install typewritten labels on inside door of each fused device, indicating fuse replacement information.

3.3 APPLICATION

A. Main Service: Class L

B. Main Feeders: Class L, Class J, or Class RK1 as indicated by Engineer

C. Motor Branch Circuits: Class J or Class RK1, dual element time delay

D. Transformer Primary Protection: Class J or Class RK1 dual element time delay

E. Other Branch Circuits: Class J or Class RK1, fast acting, current limiting or as indicated by Engineer

F. Lighting and Appliance Panelboard 208/120V, 1A-100A branch circuits: Class CF, Class CC or Plug

G. Lighting and Appliance Panelboard 480/277V, 1A-100A branch circuits: Class CF or Class CC

3.4 CLEANING

A. Clean fuses and tighten connections prior to energizing of equipment.

END OF SECTION

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

G. Section 26 2813 – Fuses

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.4 REFERENCE STANDARDS

A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

D. NFPA 70 - National Electrical Code

E. UL 98 - Enclosed and Dead Front Switches

F. UL 486A - 468B - Wire Connectors

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

H. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

A. Product Data:
   1. Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, fuse clip features, terminal lugs and all accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Test Reports:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of disconnect switches and ratings of installed fuses.
      b. Record actual locations and continuous current ratings of enclosed circuit breakers.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Siemens

2.2 DISCONNECT SWITCHES

A. NEMA KS 1, UL 98

B. Load interrupter enclosed knife switch, heavy-duty type.

C. Fusible or non-fusible type as indicated.

D. Switch Interiors:
1. Switch blades that are visible in "OFF" position when switch door is open.
2. Plated current carrying parts.
3. Removable arc suppressors to permit easy access to line side lugs.

E. Switch Mechanism:
1. Quick-make, quick-break, with visible blades and externally operable handle.
2. Lockable only in “OFF” position and accept three industrial type, heavy-duty padlocks.
3. Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open.
4. Defeater mechanism to bypass interlock.
5. Operating handle integral part of enclosure.
6. Handle to physically indicate "ON" and "OFF" position.

F. Ratings:
1. Ampacity as indicated on drawings.
2. Minimum 10kA withstand rating for non-fusible switches
3. Minimum 100kA withstand rating for fusible switches
4. Horsepower rated.

G. Fusible Switches:
1. Rejection clips for Class R fuses specified.
2. Provisions for Class J or Class L fuses, as applicable.
3. Fuses: Per requirements in Section 26 2813 – Fuses.

2.3 ENCLOSED CIRCUIT BREAKERS

A. NEMA AB 1, UL 489.

B. Enclosed molded-case circuit breakers:
1. Tripped indication clearly shown on breaker handle taking position between “ON” and “OFF”.

2. 225A frame size and below: thermal-magnetic trip.
3. 250A frame size and above: electronic (solid-state microprocessor-based) trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.
4. Locking tabs on cover to allow breaker handle to be locked in the open or closed position. When locked cover is not allowed to be removed.

C. Breaker Mechanism:
1. Quick-make, quick-break.

D. Ratings:
1. Ampacity as indicated on drawings.
2. Listed as Type HACR for air conditioning equipment circuits.
3. Listed as Type SWD for lighting circuits.
4. Interrupting rating as indicated on drawings. Minimum ratings unless otherwise noted:
a. 208/120V: 22kA
b. 480/277V: 65kA

2.4 LUGS

A. Front removable lugs.

B. Labeled for 75°C copper and aluminum conductors.

C. Multiple lugs to match number of conductors per phase.

D. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

2.5 ACCESSORIES:

A. Solid neutral assembly, where required.

B. Equipment ground kit.

C. One set of normally open (NO) auxiliary contacts, where disconnect switch is installed at a remote motor served by any type of motor controller including full and reduced voltage starters, solid state soft starters and variable frequency drives.

2.6 ENCLOSURES

A. NEMA KS 1, NEMA AB 1, UL 98, UL 489, as applicable.

B. NEMA Type 1 (dry indoor locations)
1. Code-gauge galvanized steel
2. Manufacturer’s standard gray enamel finish over prime coat

C. NEMA Type 3R (intermittently wet indoor or outdoor locations)
1. Code-gauge galvanized steel

2. Manufacturer's standard gray enamel finish over prime coat

D. NEMA Type 4X (continuously wet or corrosive locations to include cooling towers)
1. Code-gauge Type 316 stainless steel

E. Surface-mounted

2.7 SERVICE ENTRANCE

A. UL 869A

B. Switches and circuit breakers identified for use as service entrance equipment are to be labeled for this application, provided with solid neutral assembly and equipment ground bar, and must include connection for bonding and grounding of neutral conductor.

2.8 SHORT CIRCUIT CURRENT RATING

A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Verify that "touch-up" paint kit is available for repainting.

C. Provide watertight bolt-on hubs for top entry NEMA-3R and NEMA-4X enclosures.

3.2 EXAMINATION

A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.

B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.

C. Disconnect switches and enclosed circuit breakers mounting**:**
1. Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.

2. Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
3. Install two rows of steel slotted channel, with a minimum of four attachment points, for each disconnect switch and enclosed circuit breaker.
4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.

D. Do not support disconnect switches and/or enclosed circuit breakers by raceway.

E. Install top disconnect switch and/or enclosed circuit breaker handle a maximum of 6'-6" above finished floor.

F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.
1. Include switch and/or enclosed circuit breaker name, amperage, voltage, phase, and number of wires.

H. Install fuses in fusible switches at job site per requirements in Section 26 2813 – Fuses.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.

B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test disconnect switches and/or enclosed circuit breakers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Circuit Breakers: Set field-adjustable trip settings or change the trip settings, as provided by Engineer.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2913
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0812 – Power Distribution Acceptance Tests

G. Section 26 0813 – Power Distribution Acceptance Test Tables

H. Section 26 2813 – Fuses

1.2 DESCRIPTION

A. Section includes enclosed manual and magnetic motor controllers and enclosed contactors.

B. Motors shown on the drawings or specified in other Divisions of these specifications shall be provided with motorized equipment and connected under this section. Provide motor controllers and power circuit disconnect devices for all motors, unless shown or specified to be furnished with motorized equipment under other Divisions of these specifications, and/or by others, for installation by this contract.

C. Variable-frequency controllers furnished by Division 20 for installation by Division 26.

D. Motor Voltage Information:

1. Voltages available are: 120V single phase and 460 V, 3-phase. Circuits are designed for motors with voltage ratings as follows:
    a. Smaller than 1/2 hp motors: 115 V, single phase.
    b. 1/2 hp motors and larger: 460 V, 3-phase.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)

D. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 VAC or 750 VDC

E. NEMA ICS 4 – Industrial Control and Systems: Terminal Blocks

F. NEMA ICS 5 – Industrial Control and Systems: Control Circuit and Pilot Devices

G. NEMA ICS 6 – Industrial Control and Systems: Enclosures

H. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)

I. NEMA MG 1 – Motors and Generators

J. NFPA 70 – National Electrical Code

K. UL 98 – Enclosed and Dead Front Switches

L. UL 486A-486B – Wire Connectors

M. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

N. UL 508 – Industrial Control Equipment

1.4 SUBMITTALS

A. Product Data:
   1. Motor controllers: Submit catalog cut sheets showing voltage, size, rating and size of switching and overcurrent protective devices, dimensions, and enclosure details.
   2. Contactors: Submit catalog cut sheets showing voltage, size, current rating, dimensions, and enclosure details.
   3. Factory settings and time-current curves of individual protective devices.
   4. Confirm motor sizes and voltages with submittals of other Divisions of specifications, and/or by others, prior to Section submittals.

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and/or starting of product.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations and ratings of enclosed motor controllers and enclosed contactors and each overload type and size.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain motor controllers, and contactors from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

1.7 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Spare pilot lights: Furnish 1 spare lamp for every 5 installed units, but not less than 1 set of 3 of each kind.
   2. Spare Fuses: Furnish 6 spare fuses for each size installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D – Schneider Electric

B. ABB - General Electric

C. Siemens

D. Allen Bradley

2.2 MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for small motors, with bimetal type overload relay and pushbutton operator.

2.3 FULL-VOLTAGE NON-REVERSING MAGNETIC MOTOR CONTROLLERS

A. Equal to Square D Class 8536

B. Description: NEMA ICS 2, AC general-purpose, Class A, magnetic controller for induction motors rated in horsepower, three-phase and single-phase, as scheduled, except where single-phase motors scheduled to be provided with built-in overload elements:
   1. Size 1 minimum
   2. Control Voltage: **[120 VAC] [24VAC]**, 60 Hz
   3. Overload Relays: NEMA ICS 2, solid-state:
      a. Solid-state type:
         1) Class 10, 20 selectable inverse-time tripping characteristics.
         2) Non-volatile operating memory.
         3) 3:1 current adjustment range.
         4) Phase loss/phase unbalance protection.
         5) Ambient temperature insensitive.
         6) Self-powered.
         7) Manual reset. Automatic reset not acceptable.
         8) Manual trip.
         9) Visible trip indication.
   4. Features:
      a. Auxiliary Contacts: NEMA ICS 2, 3 each field-convertible contacts in addition to seal-in contact, capable of a total of 4 external interlocks.
      b. Red mushroom type E-Stop button
      c. Pilot Lights NEMA ICS 5: push-to-test LED incandescent or LED type. Red for running, green for off.
      d. Hand-Off-Auto (H-O-A) Selector Switches: Rotary type.
      e. Micro switch wired into control circuit to deenergize starter before disconnect opens.
      f. Control Power Transformers: 120V secondary, adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity in each motor controller, but not less than 150VA. Fused primary and secondary, and unfused leg of secondary bonded to enclosure.
      g. Terminals: NEMA ICS 4.
      h. Other accessories detailed or required by drawings.

2.4 COMBINATION CONTROLLERS

A. Equal to Square D Co., Class 8638 or 8539.

B. Factory-assembled motor controllers with externally operable disconnect, fusible switch type, in common enclosure; means for locking disconnect handle and means for defeating cover interlock.
   1. Fusible Switch: NEMA KS 1 and UL 98; enclosed knife switch, heavy-duty type, external operable handle, clips or pads to accommodate specified fuses:
      a. Rejection clips for Class R fuses.
      b. Provisions for Class J type fuses.

2.5 MOTOR CONTROLLER ACCESSORIES

A. Factory installed devices in controller enclosure, unless otherwise indicated, as follows:
   1. **[120 V] [24 V]** control circuits and pilot light, unless noted otherwise.

2. Red pilot light to indicate motor operation.
3. Green pilot light to indicate motor stopped.
4. Minimum wire size for control circuits: #14 AWG.
5. Stop and Lockout Pushbutton Station: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock pushbutton in depressed position with control circuit open, where indicated.

B. Control services: As scheduled on motor schedule or indicated.

2.6 LUGS

A. Labeled for 75°C copper and aluminum conductors.

B. Multiple lugs to match number of conductors per phase.

C. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

D. For equipment specified in this section and for equipment furnished under other Divisions of this specification and/or by others.

2.7 MOTOR CONTROLLERS AND CONTACTOR ENCLOSURES

A. NEMA 250, NEMA 1CS 6.

B. NEMA Type 1, Type 3R (outdoor locations) enclosure.

C. NEMA-4X for corrosive environments including cooling towers.

D. Code-gauge galvanized steel.

E. NEMA-4X enclosure is to be Type 316 Stainless Steel.

F. Manufacturer’s standard gray enamel finish over prime coat.

G. Surface-mounted.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate motor control wiring with Division 23 of these specifications.

B. Coordinate motor sizes and voltages with submittals of other Divisions of these specifications and/or by others.

C. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive motor controllers and contactors for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for motor controllers and contactors mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data.

3.3 INSTALLATION

A. Install motor controllers and contactors in accordance with ANSI/NECA 1.

B. Install level and plumb, in accordance with manufacturer's written instruction.

C. Motor controllers and contactors mounting:
   1. Fasten motor controllers and contractors firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
   2. Anchor and fasten motor controllers and contactors and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
   3. Install two rows of steel slotted channel, with minimum of four attachment points, for each motor controller and contactor.
   4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.
   5. Do not support motor controllers and contactors only by raceway.

D. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening valves. Where manufacturer's torque valves are not indicated, use those specified in UL 486A-486B.

E. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each motor controller and contactor, using small corrosion resistant metal screws or rivets. Do not use contact adhesive:
   1. Indicate motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating, overload size, and fuse size and type, when applicable.

F. Connect each motor terminal box to rigid conduit system with maximum 18" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

G. Check for proper rotation and phase relationship of each motor.

H. Install fuses in fusible switch at job site pre requirements in Section 26 2813 – Fuses.

I. Control Wiring Installation:
   1. Install wiring between motor control devices according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.
   2. Install motor control wiring in accordance with control wiring diagrams and in raceways where indicated or required by contract drawings.
   3. Bundle, train, and support wiring in enclosures.
   4. Connect hand-off-automatic switch and other automatic-control devices where applicable.
      a. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

b. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 APPLICATION

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, and configuration of pilot device and control circuit affecting controller functions.

3.5 CONNECTIONS

A. Provide green wire ground through flexible conduit to interconnect motor frame and rigid conduit system.

B. Ground and bond motor controller and contactor enclosures according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

C. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

D. Connect control wiring for operation, control and supervision of motorized equipment as shown on drawings and/or specified in this and other Divisions of these specifications.

3.6 FIELD QUALITY CONTROL

A. Inspect motor controllers and contactors for physical damage, proper alignment, connections, anchorage, and grounding.

B. Correct malfunctioning motor controllers and contactors on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test continuity of each circuit.

D. Test motor controllers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

E. Interpret test results in writing and submit to Engineer.

3.7 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.8 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings as indicated on drawings.

B. Adjust motor circuit protectors.

3.9 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 3213

DIESEL ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 1300 – Pipe, Pipe Fittings and Pipe Support

B. Section 20 2200 –Insulation - Mechanical

C. Section 22 0400 – Fuel Oil Storage and Distribution System

D. Section 23 1213 – Facility Fuel – Oil Pumps

E. Section 23 1200 – Sheet Metal and Flexible Ducts

F. Section 26 0000 – General Electrical Requirements

G. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

H. Section 26 0526 – Grounding and Bonding for Electrical Systems

I. Section 26 0529 – Hangers and Supports for Electrical Systems

J. Section 26 0812 – Power Distribution Acceptance Tests

K. Section 26 0813 – Power Distribution Acceptance Test Tables

L. Section 26 2313 – Paralleling Low-Voltage Switchgear

M. Section 26 2816 – Enclosed Switches and Circuit Breakers

N. Section 26 3623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF SYSTEM

A. Section describes complete package generator set, unit-mounted radiator cooling system, exhaust silencer, microprocessor based control and monitoring panel, battery and charger, Building Management System (BMS) communications module, remote annunciator**.**

B. Package generator set rated for emergency/standby duty as defined by ISO8528-1.

C. Engine fuel system:

1. Remote bulk fuel tank with local day tank and transfer pump assembly provided by others.

1.4 REFERENCE STANDARDS

A. ASTM-A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

B. EPA 40 CFR Part 60 – Environmental Protection Agency Code of Federal Regulation New Source Protection Standards for Stationary Sources

C. IEC8528 Part 4 – Control Systems for Generator Sets

D. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

E. ISO 8528-1 2005 - Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets

F. NEMA MG-1 – Motors and Generators

G. NETA 2007 – InterNational Electrical Testing Association

H. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines

I. NFPA 70 – National Electric Code (NEC)

J. NFPA 99 – Essential Electrical System for Health Care Facilities

K. NFPA 110 – Standard for Emergency and Standby Power Systems

L. NFPA 780 – Standard for the Installation of Lightning Protection Systems

M. SSPC-SP1 – The Society for Protective Coatings; Solvent Cleaning

N. UL 2200 – Stationary Engine Generator Assemblies

O. UL 142 – Steel Aboveground Tanks for Flammable and Combustible Liquids

P. UL 2085 – Protected Aboveground Tanks for Flammable and Combustible Liquids

1.5 SUBMITTALS

A. Shop Drawings
   1. Submit for engineering review and approval prior to production release. Include the following for engine-generator:
      a. Power output rating for emergency/standby, prime and/or continuous operation for specified ambient temperature and elevation.
      b. Outline drawings of equipment showing weights and center of gravity location for skid-mounted and enclosed units with sub-base tanks attached.
      c. Overall dimensions including bolting template **.**
      d. Right hand, left hand, end, and top views of proposed assembly
      e. Battery, battery rack, battery charger, and wiring diagrams
      f. Vibration isolation bases, mounts, and hangers
      g. Exhaust silencer and flexible fittings

h. Fuel connection locations including remote filter rack if required
i. Power and control wiring entrance locations including conduit stub window dimensions
j. Circuit breaker sizes, locations, and required clearances
k. Lug sizes and locations
l. Engine-generator control panel drawings showing devices to be provided, with each device referenced to material list with complete description for device.
m. Weather protective enclosure installation drawings, color chip options, lighting fixture catalog cut, conduit, and wiring requirements.
n. Sound level data
o. Enclosure sound performance data as applicable
p. Exhaust silencer characteristics
q. Factory certified prototype test report indicating fuel efficiency and emission levels

2. Information on engine characteristics:
   a. Make, type, and number of cylinders
   b. Brake horsepower (bhp) available
   c. Jacket water heat rejection
   d. Cooling pump characteristics
   e. Exhaust flow rate and temperature at 25, 50, 75, and 100% rated load
   f. Ventilation requirements
   g. Combustion air requirements
   h. Fuel consumption rates at 25, 50, 75, and 100% rated load
   i. Liquid refill capacities
   j. Exhaust backpressure limitation
   k. Type and manufacturer of governor
   l. Alternator size to limit voltage dip to 10% at rated kVA block load
3. Information on generator characteristics:
   a. Make and type
   b. Voltage, phase, poles, full load amps
   c. Type of construction
   d. Temperature rise
   e. Regulation characteristics
   f. Ventilation requirements
   g. Type and rating of winding insulation
   h. KW/KVA, power factor
   i. Type of exciter and voltage regulator
   j. Subtransient reactance
   k. SKVA @ 10%, 15%, and 20% voltage drop
   l. Maximum fault current contribution
4. Output Circuit Breaker Manufacturers Data
   a. Complete manufacturer’s data sheet for circuit breaker
   b. LSI adjustment parameters
   c. Trip curves

d. Auxiliary contact provisions and wiring diagrams

B. Interconnection detail drawing showing control and power connections in complete standby system. Control connections between components are to be labeled with identical nomenclature. Coordinate with generator manufacturer.

C. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.

D. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

E. Complete test specification detailing testing procedure to be used to verify performance of equipment provided.

F. Recommended spare parts lists.

G. Test Reports:
1. Submit certified factory tests report on engine-generator delivery. Alarms, sensors, and meters must be tested and certified.
2. Submit, upon completion of installation and testing of engine-generator sets, certified test reports from load tests for each engine-generator.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle equipment in accordance with manufacturer's written instructions. One copy of instructions are to be included with equipment at time of shipment. Maintain factory bracing, packaging, and wrapping.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Refer to Section 01 7700 - Closeout Procedures and herein below.

B. Submit Operation and Maintenance (O&M) manuals to Engineer for review 60 days prior to acceptance of unit.

C. Installation, maintenance, and operating instruction manuals shall include, but not limited to, the following:
1. 100% accurate system "as-installed" drawings, interconnect diagrams, schematic diagrams, wiring diagrams, individual sub-system component manuals, operation procedures, system description with theory of operation, maintenance schedules and procedures, original programmed settings and parameters, and other information necessary for the Owner to maintain, operate, test, and troubleshoot system.
2. The O&M manual shall contain step-by-step instructions for startup and shutdown. The first page shall contain name, address, and phone number of local representative to be called for service or parts. Follow with complete parts lists by actual ordering catalog numbers. O&M manual also shall contain four copies each of test record forms and service record forms for Owner use. Forms shall show proper interval for testing, servicing, and replacing of components, lubrication, filters, antifreeze, etc., including recommended specifications and fluid levels for lubricants.

3. Recommended spare parts list (with pricing) for 2 yrs of operation.

D. O&M manuals shall not solely rely on sub-component manuals. Thorough consolidation of operating and maintenance information shall be available in system overview guide. Include major components of system in overview.

E. Turn final reviewed manuals over to Owner prior to conducting training of Owner personnel.

F. Seal single copy of service record forms, recommended operation and service practices for unit in plastic and wall mount in weather-protective enclosure.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide one year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.
   1. Optional two-year and five-year warranties shall be available upon request.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:
   1. Engine Generator Set – Caterpillar
   2. Battery charger – Same as above

2.2 RATINGS AND PERFORMANCE

A. Engine Generator Set
   1. Generator kW Output: 1500 kW
   2. Altitude 3300 ft above sea level in ambient temperature of 104°F
   3. Stable frequency regulation
   4. 1875 kVA, .8 Power Factor
   5. 480/277V, 3 Ph, 60 Hz, 4 Wire Y
   6. Stable voltage regulation 0-full load less than or equal to ± .5%.

B. Generator Set Transient Performance
   1. Engine
      a. Start and load in 10 seconds per NFPA 110
      b. Accept 100% block load per NFPA 110
   2. Frequency regulation ±5% no load to full load. ± .25% steady state speed droop shall be adjustable from 0 to 10%, from no load to full load, and share within 5% when paralleled with similarly equipped engines.
   3. Alternator
      a. 15% Voltage dip at rated locked rotor kVA

b. AC waveform output contains <5% total harmonic distortion (THD) at full linear load when measured from line to neutral with <3% in any single harmonic, and no third-order harmonics or their multiples.
c. Telephone influence factor < 50
d. Telephone harmonic factor < 3
e. 6 X FLA Fault current capability

C. Factory Prototype Test Certified
1. Harmonic Distortion Levels
a. Demonstrate
2. Unit tested with factory enclosure when specified with enclosure
a. UL 2200 listed
3. 30 Degree Water Spray Unit Rain Test
a. Demonstrate no water leakage into electrical boxes
4. Fuel consumption at 25%, 50%, 75% and 100% load in gallons/hour.
5. Exhaust emissions at 25%, 50%, 75% and 100% load.

D. Factory Production Test Certified
1. Alternator Impedance to Ground
2. Dielectric Testing
a. At 1000 V and 2 times rated voltage
3. Maximum kW Rating
4. Engine Response Time
5. Alternator Construction Testing
a. Impedance Balance Tested
6. Alternator Insulation Testing
a. Surge Tested
7. Output Circuit Breaker Testing (If equipped with unit-mounted circuit breaker)
a. Circuit breaker(s) to be tested according to Section 26 0812 – Power Distribution Acceptance Tests to meet NETA 2007 and circuit breaker manufacturer’s specifications.
b. Circuit breaker manufacturer’s factory test report for each circuit breaker complying with above is acceptable if available.
8. Load Test
a. Tests to include minimum of 4 starts of engine-generator set, minimum 2 hour maintained operation under conditions of applied loads at 10 to 100% of rated capacity.
b. Provide certified results of testing, including frequency and voltage regulation at 25, 50, 75, and 100% of rated load.
c. Engine-generator set test results are to be certified to comply with specification parameters or necessary corrective actions implemented and tests repeated until compliance is certified.

2.3 FABRICATION AND MANUFACTURER

A. Engine:

1. Cylinder arrangement: Inline or V
2. Four-stroke, diesel compression cycle
3. 1800 rpm
4. Cast iron block and cylinder heads with removable cylinder liners
5. Pressurized oil lubricated
6. Water cooled
7. Fuel Type: No. 2 domestic diesel fuel oil
8. Engine accessories:
    a. Fuel filters (primary, secondary, water separator)
    b. Lube oil filters
    c. Intake air filter(s)
        1) Dry-type replaceable.
    d. Lube oil cooler
        1) Suitable for operation of generator set at full rated load in ambient temperature specified.
    e. Fuel transfer pump
        1) Capable of lifting fuel six feet
    f. Fuel priming pump
        1) Engine driven positive displacement, mechanical, full pressure
    g. Gear driven water pump
    h. Electronic direct fuel injection or have suitable emission control equipment
    i. Electric speed sensing governor capable of isochronous regulations.
9. EPA Certified
    a. Provide for engine type, horsepower, generator set duty rating, and location of installation to meet current federal and local regulations.
10. Stainless Steel Data Plate indicating:
    a. Manufacturer
    b. Date of Manufacture
    c. Location of Final Assembly
    d. Horsepower
    e. Fuel Type
    f. Quantity of Cylinders
    g. Cylinder Bore Diameter
    h. Cylinder Stroke Length
    i. RPM
    j. EPA Certification

B. Cooling System:
1. Engine skid mounted, engine-driven fan cooled radiator with prop type fan, sized to maintain safe operation at 122°F ambient temperature.
2. Provide radiator with:
    a. Engine-driven fan

b. Core guard
c. Fan guard
d. Mounting hardware
e. Direct adapter flange. Ductwork with flexible connection between radiator and exhaust plenum to be provided by Division 23 for indoor applications. Coordinate with Division 23.
f. Flexible pipe connections at engine and radiator
g. User accessible, pressure regulating fill cap with overflow surge container

3. Block Heater
   a. Water Jacket Heater: Circulating type with inlet and outlet valves and removable connections to allow for replacement.
   b. Sized to maintain engine jacket water to 70°F in ambient temperature of 0°F
   c. Heater to be equipped with thermostatic switch
   d. Single phase 208 V
4. Fill engine cooling system with solution of water/ethylene glycol at initial fill meeting -40F.
5. Ductwork with flexible connection between radiator and exhaust dampers to be provided by others. Refer to Section 23 3114 – Ductwork.

C. Exhaust System:
1. Furnish engine exhaust critical grade silencer:
   a. Sized according to engine manufacturer's recommendations for backpressure
   b. Meeting sound attenuation requirements of installation site
   c. Mount so weight is not supported by engine
   d. Flexible exhaust fitting
   e. Diesel Oxidation Catalyst Filter included (Combination Critical Grade Silencer/Catalyst)
      1) 304 stainless steel housing with removable catalyst
   f. 4” thick removable insulation blanket.
   g. Installation: Indoors by Mechanical Contractor
   h. Refer to Section 23 2118 – Pipe and Pipe Fittings
2. Condensate Traps
   a. Drain plug at low point of muffler
3. Thermal Expansion
   a. Stainless steel exhaust flex to accommodate thermal growth and vibration isolation
4. Thimble
   a. Pipe and wall of compatible construction
5. Exhaust clearing area

D. Starting System
1. Comply with NFPA 110, Level 1
2. Provide DC electric starting system with positive engagement drive. Provide DC voltage recommended by manufacturer.
3. Provide fully automatic start-stop controls.
4. Provide cycle cranking to open and lock out start circuit after 3 attempts to start failed engine start.

5. Batteries
   a. Provide valve regulated lead-acid storage battery set:
      1) Heavy duty diesel starting type
      2) Voltage compatible with starting system voltage
      3) Capacity to provide for 75 seconds total cranking time at 0°F without recharging in accordance with NFPA 110, Level 1.
   b. Provide vinyl or epoxy coated steel battery rack.
   c. Battery cables and clamps
6. Battery Charger
   a. Dual Rate Battery Charger
      1) Constant current, and float equalized
   b. Charger Accessories:
      1) Overload protection
      2) ±1% line and load regulation
      3) Electronic current limit output 105%
      4) DC ammeter and voltmeter digital meter with ±2% volt accuracy, ±5% amp accuracy.
      5) UL 1236 listed and meets NFPA 110 requirements
      6) Output protection
      7) Temperature compensation
      8) Enclosed in NEMA 1 aluminum or stainless steel enclosure
      9) Form C contacts for the following alarms
         a) AC fail
         b) Low battery volts
         c) High battery volts
         d) Charger fail
         e) Battery fault
7. AC input voltage: 120 V
8. When installed on the engine generator set, mount on vibration isolators.

E. Speed Control
   1. Mechanical: 1% droop
   2. Electronic: Isochronous

F. Alternator:
   1. Maximum temperature rise 105°C at 40°C ambient
   2. Copper windings
   3. Synchronous type
   4. Self ventilated
   5. Drip-proof construction
   6. Directly connected to engine flywheel housing with a flex coupling
   7. Capable of sustaining 300% overcurrent for 10 seconds under a 3-phase symmetrical short circuit
   8. Subtransient Reactance limited to 15% maximum

9. Insulation
    a. Complies with NEMA (MG1-33.4, MG1-22.40, and MG-1-16.40)
    b. Class H Insulation Systems
        1) UL 1449 recognized
        2) Vacuum impregnated with epoxy varnish
        3) Fungus resistant
10. Permanent magnet brushless excitation (PMG).
    a. PMG shall derive excitation current from pilot exciter mounted on the rotor shaft. It is to be able to sustain 300% of rated current for ten seconds during a fault condition.
    b. Self-excited system to be brushless and consist of a 3-phase armature and a 3-phase full wave bridge rectifier mounted on the rotor shaft. Include surge suppressors to protect the diodes from voltage spikes.
11. Rotor
    a. 4 pole
    b. Winding
        1) Form Wound
    c. Varnish process
        1) Epoxy based material applied to each layer of magnet wire
    d. Coil supports
        1) Driven through flexible coupling to ensure permanent alignment.
    e. End winding spacing
    f. Amortisseur windings
    g. Bearings
        1) Sealed
12. Stator
    a. 3-phase copper winding
    b. Laminations
    c. Cooling air passages and fan
    d. Welded laminations to prevent cutting of wires
    e. Skewed stack to minimize slot ripple on output voltage and produce smooth voltage waveform.
    f. Pitch – Skewed design to optimize efficiency and minimize total harmonic distortion.
    g. Varnish process
        1) 2 dips and bakes using Class A impregnating varnish
13. Alternator Components
    a. Strip Heater: 120V
    b. Solid state design digital voltage regulator:
        1) Performance
            a) Microprocessor based.
            b) Programmable
            c) Regulation: ± .5% at any constant load for any load from 0% to 100% of pf rating.
            d) 3-phase, true RMS sensing

e) PMG input, engine unloading
f) Design insensitive to severe, load induced wave shape distortion from SCR or thyrister circuits such as those used in battery charging, UPS, and motor speed control equipment loads.
g) Controls to limit build-up of AC generator voltage to provide a linear rise and limit overshoot.
h) Digital adjustments for output voltage adjustment gain, damping and frequency rate–off, and reactive droop adjustment to allow paralleling.
i) System setup controls and fault alarms.

2) Protection
a) Overcurrent based on damage curve
b) Over-excitation protection
c) Electronic voltage buildup protection
d) Loss of sensing protection
e) Temperature compensation
f) Limitation of voltage overshoot on startup
g) Ground fault alarm: protection relay to provide alarm for ground fault adjustable from 10A to 1200A with delay settings up to 1 second. Manufacturer's standard ground fault protection to meet warranty requirements are to be maintained.

3) Features
a) Parallel support
b) VAR/PF control

4) Environmentally sealed
5) UL 508A listing

c. Unit-Mounted Output Circuit Breaker(s)
1) 100% rated circuit breaker(s) with adjustable trip meeting the requirements for circuit breakers in Section 26 2816 - Enclosed Switches and Circuit Breakers
2) Adjustable long time, long time delay, short time, and short time delay curve shaping elements
3) Shunt Trip for integration with load bank controls and closed transition transfer switches.
4) Position indicating contacts to alarm when breaker is in the open position
5) Load side connections suitable for compression cable lugs
6) NEC required access in front of breaker

d. Stainless Steel Data Plate Indicating:
1) Manufacturer
2) Date of Manufacture
3) Location of Final Assembly
4) KVA/KW/PF
5) Voltage/Phase
6) Full Load Amps
7) Poles
8) Temperature Rise

9) Insulation Class/Temp

G. Instrument Panel
1. Dual range voltmeter 3 1/2-inch, +/- 2% accuracy.
2. Dual range ammeter 3 1/2-inch, +/- 2% accuracy.
3. Voltmeter-ammeter phase selector switch.
4. Lights to indicate high or low meter scale.
5. Direct reading pointer-type frequency meter 3 1/2-inch, 0.5% accuracy, 45 to 65 Hz scale.
6. Panel illuminating lights.
7. Battery charging voltmeter.
8. Coolant temperature gauge.
9. Oil pressure gauge
10. Running time meter
11. Voltage adjust rheostat.

H. Controls:
1. Meets NFPA 110 requirements
2. Micro-processor based solid state controls to automatically start, protect and monitor engine-generator set with panel illuminating lighting and digital display.
3. Control panel includes:
   a. Solid state trip main circuit breaker
   b. Motor starting switch
   c. Electrically operated fuel control
   d. Relay to disconnect battery charger during cranking
   e. Switching lamps and meters to be oil tight and dust tight. All active components to be installed within a NEMA 3R enclosure. There shall be no exposed components with door open operating 750 V.
   f. Protective relays to open main circuit breaker and shut down and lockout engine on abnormal conditions including:
      1) Overcrank
      2) Overspeed
      3) Low lube oil pressure
      4) High Engine Temp
      5) Operation of Remote Stop
   g. Monitoring items shall include but is not limited to the following items and control:
      1) Coolant temperature
      2) Oil pressure
      3) Battery voltage
      4) RPM
      5) Voltmeter, digital or analog type having 0.5% accuracy with selector switch for L-L, L-N
      6) Ammeter, digital or analog type having 0.5% accuracy with selector switch for phases A, B, C, N.

7) Frequency meter, 55-65 Hz ±0.125 Hz.
8) Running Time Meter (hours and 1/10 hours), non-resettable
9) AC power metering to be 0.5% accuracy and include frequency, phase, selector switch with real time power metering including, kW, kVA, kVAR, kWh, PF, % of rated load.

h. Control Items:
1) Comply with NFPA 110, Level 1
2) Voltage and Frequency adjustment
3) Overspeed level adjustment
4) Overvoltage level adjustment
5) Undervoltage level adjustment
6) Overfrequency level adjustment
7) Underfrequency level adjustment
8) Four position key function switch marked AUTO, MANUAL RUN, OFF/RESET and STOP
9) 4 NO and 4 NC dry contacts for local and remote alarms, wired to terminal strips.
10) Emergency off mushroom button
11) Automatic remote start capability. Engine cranking system to permit minimum 3 cranking attempts of 15 seconds duration with rest of periods of 15 seconds.
a) Overcrank lockout shall occur after 3 cranking attempts.

i. In accordance with NFPA 110, Level 1, control panel shall furnish battery-powered individual visual alarm indicator functions at battery voltage and visual and audible pre-alarm, with terminals provided for each signal:
1) Overcrank (red)
2) Low water temperature
3) High engine temperature pre-alarm (yellow)
4) High engine temperature (red)
5) Low lube oil pressure pre-alarm (yellow)
6) Low lube oil pressure (red)
7) Air damper (red)
8) Overspeed (red)
9) Low fuel main tank (red)
10) Low coolant level
11) EPS supplying load
12) Control switch not in automatic position (flashing red)
13) High battery voltage
14) Low cranking voltage
15) Low voltage in battery (red)
16) Auxiliary Prealarm (yellow)
17) Auxiliary Fault (red)
18) Battery charger ac failure (red)
19) System Ready (green)

20) Lamp test
21) Contacts for local and remote common alarm
22) Spare

j. Engine shut down, with audible alarm:
1) Low oil pressure
2) High engine temperature
3) Overcrank
4) Overspeed
5) Remote Emergency Stop
6) Overcurrent (circuit breaker trap and lockout)
7) Reverse power
8) Low-coolant level
9) Fail to synchronize

k. Status report to building Fire Alarm Panel:
1) Engine running
2) Circuit breaker open
3) Circuit breaker closed
4) Generator Fault (Common Alarm)

4. Visual alarm resettable only after fault condition has been corrected.
5. Audible alarm shall include silencing circuit, which, after activation, will permit annunciation of subsequent failures.
6. Control Panel mounting:
a. Mounted on engine generator set in NEMA 1 enclosure on shock isolators
7. Provide remote annunciator panel(s) as indicated on drawings
a. Compliant with NFPA 110 Level 1 requirements
b. Powered from engine starting batteries
c. Hardwired from generator to annunciator

I. Isolate engine generator set from building structure and from connecting services.
1. Separately derived grounding system. Connect generator ground as shown on drawings to grounding electrode system.
2. Bond generator neutral to ground bonding strap to solid grounding location.

J. Termination Bars and Connections:
1. Silver or tin-plated copper bus bars for terminating cables.
2. Standard NEMA standard bolt hole spacing, for 3-phase and neutral, within generator connection box with gasketed bolt on cover. Use two-hole, long barrel compression cable lugs only.
3. Engine-generator set control interfaces to other system components to be made on a permanently labeled terminal block assembly. Provide labels describing connection points.
4. Connections to engine-generator set: Flexible or isolation type connections. Include electrical, fuel, exhaust, and ventilation connections.

K. Equipment Bases:

1. Mount complete unit on a structural steel sub-base, rectangular in shape, with sufficient rigidity to maintain alignment of generator set. Provide perimeter beams with minimum depth equal to 1/10 of longest dimension of base, except beam depth need not exceed 14" provided that deflection and misalignment are kept within acceptable limits as determined by manufacturer. Engine-generator set to be statically and dynamically balanced at factory. Peak-to-peak amplitude of vibration velocity in horizontal, vertical, and axial direction shall not exceed 0.65" per second at main structural components.
2. Engine-generator set weight distribution is to be considered to provide uniform deflections.
3. Bases shall provide equipment alignment and assure uniform weight distribution.

L. Vibration Isolators:
1. Provide spring isolators with shipping locks to be removed at time of installation. Isolators shall have a minimum of 3/4" deflection at rated load.
2. Prevent equipment vibrations from being transmitted to enclosure for outdoor units.
3. Required between the structural steel sub-base and concrete housekeeping pad for indoor and outdoor units.
4. Steel or cast iron top and bottom housings incorporating 1 or more steel springs with built-in leveling bolts and built-in resilient chocks to control oscillation and withstand lateral forces in all directions.

M. Fuel System
1. Day Tank
a. Mechanical Contractor to provide day tank system. Refer to Section 23 1214 - Liquid Fuel Systems.
2. Remote Fuel Tank
a. Fuel tank provided by Mechanical Contractor. Refer to Section 23 1214 – Liquid Fuel Systems.

2.4 INTERFACE WITH BUILDING MANAGEMENT SYSTEM (BMS)

A. Interface shall be as follows:
1. Control panel shall incorporate communication module with digital communication port connection to building control system (BMS) via BACnet communication.
2. Communications shall be for the following:

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 1	Low lube oil pressure prealarm	
LDI 2	Low water temperature	
LDI 3	High engine temperature prealarm	
LDI 4	Battery charger AC failure	
LDI 5	Spare	
LDI 6	Control switch not in automatic position	
LDI 7	High battery voltage	
LDI 8	Low coolant level	
LDI 9	Low cranking voltage	
LDI 10	Low voltage in battery	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 11	EPS supplying loads	
LDI 12	Generator circuit breaker ground fault	
LDI 13	Low lube oil pressure	
LDI 14	High engine temperature	
LDI 15	Overcrank	
LDI 16	Overspeed	
LDI 17	Remote emergency manual stop switch	
LDI 18	Overcurrent (circuit breaker trip and lockout)	
LDI 19	Reverse power relay trip	
LDI 20	Failure to synchronize	
LDI 21	Engine running	
LDI 22	Generator running	
LDI 23	Generator circuit breaker open	
LDI 24	Generator circuit breaker closed	
LDI 25	Generator circuit breaker failed to close	
LDI 26	Spare	
LDI 27	Control voltage failure	
LDI 28	Auto start	
LDI 29	Battery charger failure	
LDI 30	Spare	
LDI 31	Spare	
LDI 32	Spare	
LDI 33	Sub-base fuel storage leak	
LDI 34	Spare	
LDI 35	Spare	
LDI 36	Spare	
LDI 37	Spare	
LDI 38	Spare	
LDI 39	Spare	
LDI 40	Spare	
LDI 41	Spare	
LDI 42	Load shed activated Priority #2	
LDI 43	Load shed activated Priority #3	
LDI 44	Load shed activated Priority #4	
LDI 45	Load shed activated Priority #5	
LDI 46	Load shed activated Priority #6 (spare)	
LDI 47	Load shed activated Priority #7 (spare)	
LDI 48	Load shed activated Priority #8 (spare)	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDI 49	Load demand activated Priority #2	
LDI 50	Load demand activated Priority #3	
LDI 51	Load demand activated Priority #4	
LDI 52	Load demand activated Priority #5	
LDI 53	Load demand activated Priority #6 (spare)	
LDI 54	Load demand activated Priority #7 (spare)	
LDI 55	Load demand activated Priority #8 (spare)	
LDI 56	Air damper closed	
LDI 57	System test mode (lamp test)	
LDI 58	Spare	
LDI 59	Spare	
LDI 60	Spare	
LDI 61	Spare	
LAI 1	Generator phase A-B voltage	Volts
LAI 2	Generator phase B-C voltage	Volts
LAI 3	Generator phase C-A voltage	Volts
LAI 4	Generator phase A current	Amperes
LAI 5	Generator phase B current	Amperes
LAI 6	Generator phase C current	Amperes
LAI 7	Total real power	KW
LAI 8	Total apparent power	KVA
LAI 9	Total reactive power	KVAR
LAI 10	Generator power factor	
LAI 11	Generator phase A frequency	Hertz
LAI 12	Generator phase B frequency	Hertz
LAI 13	Generator phase C frequency	Hertz
LAI 14	Battery voltage	Volts
LAI 15	Engine oil pressure	KPA
LAI 16	Engine speed	RPM
LAI 17	Engine water temperature	Degrees Centigrade
LAI 18	Engine running time	Hours
LAI 19	Spare	
LAI 20	Spare	
LAI 21	Spare	
LDO 1	Remote fault reset	
LDO 2	Remote start initiative	
LDO 3	Cool down override control	
LDO 4	Phase select	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LDO 5	Load adding and load shedding	

Notes:

LDI - LAN: Digital Input from control panel communication module to BMS via Ethernet communication.

LAI - LAN: Analog Input from control panel communication module to BMS via Ethernet communication.

LDO - LAN: Digital Output from BMS to communication module via Ethernet communication.

LAN – Local Area Network

3. Provide all additional information as required for a complete and operable system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install engine-generator set and associated equipment as indicated. Coordinate final location of equipment with General Contractor. Final location of equipment to be reviewed with Engineer prior to installation.

B. Install equipment in accordance with manufacturer's recommendations. Provide equipment protection during and subsequent to installation.

C. Mount generator on concrete equipment pad according to manufacturer’s instructions and meeting requirements stated in Section 26 0529 – Hangers and Supports for Electrical Systems.

D. Mount generator level and square with equipment pad. Remove spring isolator transport locks and adjust spring isolators to allow free movement.

E. Connect battery charger to engine starting system. Do not connect charger output directly to starting batteries.

F. Fuel connections for remote fuel tank and day tank to be provided by Mechanical Contractor as applicable.

G. Exhaust connections for indoor applications are to be provided by Mechanical contractor.

H. Provide communications connections for BAS system to generator communications modem.

I. Provide connection and mounting of remote annunciator(s) as shown on drawings.

J. Provide connection of start/stop controls from transfer switches and/or paralleling switchgear as applicable.

K. Provide connection to building fire alarm system as indicated on drawings.

L. Provide connection from fuel tank leak detection sensor to remote leak detection panel and BAS system as applicable.

M. Provide connection of circuit breaker position indicating contacts to generator status alarm input and paralleling switchgear as applicable.

N. Provide power connections to circuit breaker terminals or alternator connection bus using compression lugs or lugs as provided by circuit breaker manufacturer. Torque lugs to manufacturer's specifications.

O. Bond generator neutral bonding strap to generator ground bonding location. Ground generator to power conduit grounding bushings and local ground rod or counterpoise stub location and as indicated in Section 26 0526 – Grounding and Bonding for Electrical Systems. Ground fuel tanks to building grounding system in accordance with NFPA 780.

P. Terminate enclosure lighting, block heater battery heater and other enclosure accessories to incoming power connections as indicated on drawings and as applicable.

Q. Adjust generator frequency output to 60.1Hz to allow transfer switch in-phase monitor and closed transfer switches to function in a reasonable time period.

3.2 ACCEPTANCE TESTS

A. Testing by Testing Agency

B. Perform Acceptance Testing in accordance with Section 26 0812 - Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables.

3.3 ACCEPTANCE LOAD TEST (ON-SITE)

A. Conduct load testing of engine-generator set, under direct supervision of factory-authorized representatives of manufacturers of engine-generator set and auto-transfer switch.

B. Tests to include minimum of 10 starts of engine-generator set, minimum of 10 operations of auto-transfer switch, 6 hour maintained operation under conditions of applied loads at 10 to 100% of rated capacity.

1. Loading shall be by use of load banks and connections provided by installing contractor.
2. Fuel for testing is to be furnished by installing contractor.

C. Tests to comply with latest NFPA 110 and local AHJ requirements in addition to testing required in this and other specification sections referenced in this section

D. Provide certified results of testing, including frequency and voltage regulation at 25, 50, 75, and 100% of rated load at actual measured values for pickup and drop out relays for ATS, measured values for time delay relays.

E. Engine-generator set test results are to be certified to comply with specification parameters or necessary corrective actions implemented and tests repeated until compliance is certified.

F. At conclusion of testing, service engine-generator set including replacing air, oil and fuel filters, changing lubrication oil, checking and refilling batteries, adjusting fan belts for proper tightness, and refilling of cooling system as required. Refill fuel tank. Set is to be cleaned and placed into service in a condition satisfactory to the Owner.

END OF SECTION

SECTION 26 3623

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0529 – Hangers and Supports for Electrical Systems

C. Section 26 0533 – Electrical Systems Identification

D. Section 26 2713 - Electrical Metering

E. Section 26 2313 – Paralleling Low Voltage Switchgear

F. Section 26 3213 – Diesel Engine Generators

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF SYSTEM

A. Provide automatic transfer switch(es), 3 phase, 60 Hz, 3 and 4 pole. Units with 4-poles are to have overlapping neutral for voltage and current as indicated on drawings.

B. Provide Bypass Isolation Transfer Switches with removable switch mechanism as indicated on drawings.

1.4 REFERENCE STANDARDS

A. ANSI Z535.4-2011 – Product Safety Signs and Labels

B. ICS 10 Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment

C. UL1008 Automatic Transfer Switches

D. NFPA 70 National Electric Code

E. NFPA 110 Standard for Emergency and Standby Power Systems

1.5 SUBMITTALS

A. Submit shop Drawings for equipment provided under this Section.

B. Shop Drawings are to include at a minimum:
   1. Enclosure Withstand Rating
   2. Switch Close-On Rating

3. Cabinet dimensions and working clearance requirements
4. Side and rear access requirements if applicable
5. Shipping split dimensions and weights
6. Switch maximum continuous current, operating voltage, number of poles
7. Adjustable relay parameters (min/max/default)
8. Options selected
9. Internal wiring diagram
10. Line/Load conductor lug provisions and location
11. Communications provisions and number/type of ports
12. Metering provisions
13. Alarms/User interface diagrams

C. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

1.6 QUALITY ASSURANCE

A. Obtain automatic transfer switches from one source and by single manufacturer.

B. Regulatory Requirements:
1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Factory Prototype Test
1. Test system in accordance at the factory in accordance with Section 26 0812 - Power Distribution Acceptance Tests and Demonstration of Transfer Functions.
2. Provide factory test report.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion or as stated in contract documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:
   1. Russelectric

B. Acceptable Fire Pump ATS manufacturers:
   1. Firetrol
   2. Joslyn Clark
   3. Metron

2.2 AUTO-TRANSFER SWITCH

A. Auto-transfer switch:
   1. Mechanically held, electrically operated type.
   2. Open transition switches are to be interlocked to ensure one of only two possible positions, normal and emergency.
   3. Delayed transition transfer switches are to have 3 possible positions: normal, neutral-hold (center-off), and emergency.
   4. Closed transitions transfer switches are to have two possible simultaneous positions, normal and emergency.
   5. Rated for continuous duty in unventilated sheet metal enclosure.
   6. Suitable for all classes of loads at maximum rated voltages.
   7. Withstand rating that meets or exceeds withstand rating of transfer switch feeder breakers.

B. Provide main contacts with silver alloy wiping action type protected by arcing contacts.

C. Provide switch components accessible from front of enclosure.

D. Provide 3 cycle short circuit rating to guarantee contact opening and no damage when transfer switch is served by circuit breakers.

E. Provide transfer switches with the following items:
   1. Adjustable 1 to 3 second time delay to override momentary voltage dips and outages.
   2. Time delay on transfer to emergency. Adjustable from 1 to 300 seconds (factory set at 3 seconds).
   3. Time delay on retransfer to normal. Adjustable from 2 seconds to 30 minutes.
   4. Full phase protection consisting of 2 phase relays and one close differential relay. Phase relays shall be set to 70% drop out, 90% pick up, and differential relays set for 92 to 95% pick-up and 83 to 85% drop-out.
   5. Pushbutton reset to normal.
   6. Pushbutton to bypass time delay on retransfer to normal.
   7. Pilot light (green) to indicate normal source accepted.

8. Pilot light (green) to indicate switch in normal position.
9. Pilot light (red) to indicate emergency source accepted.
10. Pilot light (red) to indicate switch in emergency position.
11. Pilot light (yellow) to indicate alarm silenced.
12. Auxiliary contact to close when normal power fails.
13. Auxiliary contact to open when normal power fails.
14. Auxiliary contact on same shaft as main contacts (closed on normal).
15. Auxiliary contact on same shaft as main contacts (closed on emergency).
16. Four position selector switch to provide "Test," "Auto," "OFF", and "Engine Start."
17. Contacts to start engine-generator when normal power fails.
18. Time delay engine start, adjustable from 0 to 5 seconds.
19. Adjustable time delay on retransfer to normal source with 5 minute unloaded running time of standby plant:
    a. Minimum delay 2 minutes
    b. Maximum delay 25 minutes
    c. Built in circuitry to nullify time delay if emergency source fails and power is available at normal source.
20. Relay to prevent transfer to emergency until voltage and frequency of generating plant have reached 90% of rated value.
21. Provide bi-direction in-phase monitor adjustable to +/- 10° phase angle differential.
22. Digital RMS meter connected to transfer switch load contacts indicating at a minimum:
    a. Voltage per phase L-L, L-N
    b. RMS Current per phase
    c. RMS Peak current measured with reset
    d. KW/KVA/KVAR/PF
23. Auxiliary External Power Supply to supply control power to ATS controllers for switches that select between two normally unavailable sources such as two generators.
24. Load control relays
    a. Load add/shed active
    b. Load shed Enable/Disable
    c. Block transfer
25. Provide delayed transition switch(es) as indicated on drawings with dual motor operator with programmed neutral to allow voltage decay in motor and transformer circuits. Provide adjustable neutral-hold time delay.
26. Provide open, closed, delayed transition switch(es) as indicated on drawings with dual motor operator for make-before-break paralleled connection of both sources. Provide in-phase monitor and protective reverse power relays and other protective controls as required by the utility. Provide shunt trip control relay to open generator breaker in case of extended paralleling situation.

F. Bypass/Isolation switch:
   1. Dual-source enclosed.
   2. Isolate transfer switch and de-energize for maintenance, testing or repair.

3. Dual-source operation - bypass either to normal or emergency source directly to load at discretion of operator.
4. Break-before-make operation of contacts.
5. Operation - fully mechanical, designed to provide quick-make-quick-break of contacts and only allow switch to be fully closed or fully open with no mid position possible.
6. Operation - possible regardless of the position or condition of the automatic transfer switch.

2.3 FIRE PUMP AUTOMATIC TRANSFER SWITCH:

A. Fire pump ATS is upstream of a fire pump controller/ATS. Interconnect fire pump ATS with the fire pump controller lock-out circuit. Coordinate wiring requirements with fire pump controller provider.

B. Shall be completely assembled, wired, and tested by control manufacturer before shipment from factory.

C. Shall be listed for NFPA20 & NFPA 1008 compliance.

D. Shall be combined manual and automatic.

E. Heavy gauge formed steel, NEMA Type 3R enclosure with top drip hood.

F. Provide complete with following:
1. Isolating Switch: Externally operable, quick-break type
2. Pilot light to show circuit breaker closed and power available
3. Ammeter and voltmeter displays on front of panel
4. Alarm relay to energize audible or visible alarm
5. With Automatic Transfer Switch
6. Voltage surge protection

2.4 ELEVATOR CONTROL INTERFACE

A. Provide auxiliary contacts to provide emergency system status to elevator controller.

B. Contacts required are:
1. Emergency power signal
2. Pre-transfer warning signal

C. Pre-transfer warning signal relay to change state prior to operation of transfer switch in either direction.

D. These contacts are in addition to other required contacts.

2.5 PARALLELING SWITCHGEAR INTERFACE

A. Engine Start/Stop
1. Coordinate the paralleling switchgear and genset requirements.
2. Start/Stop signal is to be hardwired from ATS to paralleling gear inputs in dedicated metallic raceway.

B. Load Shed/Add

1. Coordinate requirements with paralleling gear requirements.
2. Load shed/add communication is to be hardwired from switch to paralleling gear inputs in dedicated metallic raceway. LAN or other network communications for load shed/add signals as a primary means is not allowed.
3. Display on ATS is to indicate when ATS is under a shed condition.

C. Status Communications
1. Transfer switch is to communicate status, alarms and meter data to paralleling switchgear and Tridium BAS by means of Ethernet open protocol BACNET.
2. Bypass switches are to annunciate to paralleling switchgear and BAS when switch is placed in the bypass position.

2.6 ATS ETHERNET COMMUNICATIONS

A. Ethernet Communications Interface – The controller shall be capable of interfacing, through an Ethernet over TCP/IP module, with a network of transfer switches, locally (up to 100m) or remotely through a LAN. Standard software specific to transfer switch applications shall be available by the ATS manufacturer. The software shall allow for monitoring, control, and setup of parameters.

2.7 ATS MONITORING AND CONTROL SYSTEM

A. Provide Critical Power Monitoring system for monitoring and control of transfer switches, ATS metering and status gateway. The CPMS system shall conform to the requirements of BSMI, CE, FCC and UL.

B. The CPMS shall include a Windows 7 based touch panel PC with the following hardware specifications.
1. 15” Touch Panel LCD display
2. Flash Memory 16GB
3. Hard Drive Memory – None
4. USB Ports (2)
5. 1000 Mbps Ethernet Port
6. Network Modbus Protocol (Only)
7. Interface with BMS System
8. Server

C. The CPMS software shall allow for Web Browsing from clients on the same LAN. The following security measures shall be provided.
1. Login Security
2. Three Levels of Security Access
3. 128 bit AES Encryption
4. Auto log out
5. Firewall on server

D. The CPMS Overview Screen default graphical representation shall display all automatic transfer switches, transfer switch metering and generator set. The graphical representation shall be “drag and drop”, allowing to arrange automatically detected devices. User shall be able to click on graphical representation to view transfer switch or generator set screens.

E. Transfer Switch Screen shall be a color graphical representation displaying real time information on the transfer switch status, voltage, frequency, and load. The graphical representation shall include bypass isolation status. The transfer switches shall have the ability to be controlled through “Transfer” “Re-Transfer” and “Bypass time delay” switch operations. Transfer switch settings and event log shall be viewable from the CPMS.

F. Transfer switch and generator set power metering functions shall be displayed including instantaneous watt demand, maximum watt demand and demand size window in minutes.

G. System shall be capable of system alarm notification via Email. The user shall have the ability to configure alarm settings; activate alarms, acknowledge alarms and add multiple email recipients.

H. CPMS shall maintain a database of alarming and trending history.

I. The CPM shall generate a diagnostic log report identifying for use by factory certified technicians.

J. A real-time mimic graphic of the transfer switch controller display screen will display the status of each individual transfer switch.

K. Transfer switch monitoring system shall be capable of displaying the following:
   1. System KW, KVA, KVAR, PF
   2. Phase KW, KVA, KVAR, PF
   3. System average current
   4. Phase current
   5. Current unbalance percentage
   6. Line to neutral voltage
   7. Average line to line voltage
   8. Average line to neutral voltage
   9. Line to line voltage unbalance percentage
   10. Line to neutral voltage unbalance percentage
   11. kWh import on normal and emergency
   12. kWh export on normal and emergency
   13. kWh net on normal and emergency
   14. kVARh lag on normal and emergency
   15. kVARh lead on normal and emergency
   16. kVARh net on normal and emergency
   17. kVAh net on normal and emergency
   18. Instantaneous watt demand in kW
   19. Maximum watt demand in kW
   20. Demand window size in minutes

L. Transfer switches equipped with a power metering and status gateway (85S) a trending function will be available to generate trend lines for kilowatts, Current, Voltage or Frequency over intervals of 1 minute, 15 minutes, 30 minutes or an 1 hour. Phase kW, total kW, and phase current, average current, line to line voltage, average line to neutral voltage and frequency real-time values shall be displayed within the trend line legend for the respective value.

M. Include page that will display current alarm on transfer switch as well as historic alarms. The screen will provide details including device name, alarm name, date and time of alarm, status, acknowledge date, deactivation date and the user's predefined level of severity for that alarm type. The ability to acknowledge selected alarms or alarms will be available on that page.

N. Include page that will display events on transfer switch. If a transfer switch is equipped with a power metering and status gateway (85S) the ability to display events on the devices separately or together.

2.8 ATS Remote Annunciator

A. Provide remote annunciator(s) in the fire command center to provide remote visual status reporting of all automatic transfer switches.

B. The recessed panel(s) shall contain the following:

a. LED indicators shall indicate the position of each transfer switch.

b. Source availability.

c. Lamp test button.

d. Power ON light.

C. Each indicator shall be labeled using the name of the transfer switch depicted on the one-line diagrams

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations and complying with Section 26 0529 – Hangers and Supports for Electrical Systems.

B. Provide side and rear access as required by manufacturer.

C. Provide equipment protection during and subsequent to installation.

D. Floor-mounted switches are to be placed on concrete housekeeping pads meeting requirements in Section 26 0529 – Hangers and Supports for Electrical Systems.

E. Provide wiring between transfer switch and elevator controller. Final connections at elevator controller by Elevator Contractor.

F. Provide wiring between transfer switch and generator controller for start/stop control.

G. Provide shunt trip wiring between transfer switch and generator breaker for closed transition transfer switches.

H. Connect transfer switches that are part of fire pump controllers.

I. Use only compression lugs unless prohibited by the switch manufacturer. Torque lugs to manufacturer's specifications.

J. Make adjustments to relay settings provided by Engineer.

K. Provide LAN and communications connections to building LAN and/or BAS as needed. Obtain IP addresses from Owner/BAS contractor.

L. Provide load add/shed and communications cabling from ATS to paralleling switchgear.

M. Provide wiring between transfer switches and remote annunciators.

3.2 IDENTIFICATION

A. Provide equipment identification complying with Section 26 0533 – Electrical Systems Identification

B. Minimum equipment identification is to include:
1. Unique Equipment Identification
2. Voltage
3. Amperage
4. Poles
5. Normal Source Name
6. Emergency Source Name
7. Load Name
8. System Type (Life Safety, Legally Required, Critical, Equipment, Standby)
9. Priority (when controlled by paralleling switchgear)

C. Provide Warning Labels Meeting ANSI, OSHA and NFPA 70E Requirements to Include:
1. “Equipment Fed From Multiple Sources”
2. “Emergency Equipment – May Start at Any Time”
3. “Emergency Life Safety System – Do Not Leave in the ‘OFF’ Position”
4. Arcflash warning labels per NFPA 70 ART 110.16
5. All labels are to meet specification guidelines found in ANSI Z535.4-2011

3.3 OPERATION

A. Parallel "start engine-generator" contacts of automatic transfer switches, such that failure of normal source at any switch shall start engine.

B. Transfer of one switch from normal to emergency shall not preclude any other switch from transferring.

C. Engine generator cool down cycle shall not start until all transfer switches have timed out back to normal source.

3.4 ACCEPTANCE TESTING

A. Testing by Testing Agency

B. Perform acceptance testing in accordance with Section 26 0812 – Power Distribution Acceptance Tests.

C. Adjust or replace equipment as needed to comply with manufacturer's specifications and resubmit corrected test reports.

END OF SECTION

SECTION 26 4113

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 – Grounding and Bonding for Electrical Systems

B. Section 26 0533 – Raceway and Boxes for Electrical Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes lightning protection systems consisting of air terminals, roof conductors, bonding conductors, down conductors, fastener connections, and grounding.

1.4 REFERENCE STANDARDS

A. ANSI/NEMA GR1 - Grounding Rod Electrodes and Ground Rod Electrode Couplings

B. NFPA 70 - National Electrical Code

C. NFPA 780 - Standard for the Installation of Lightning Protection Systems

D. UL 96 - Lightning Protection Components

E. UL 96A - Installation Requirements for Lightning Protection Systems

1.5 SUBMITTALS

A. Product Data:
   1. Submit manufacturer’s descriptive and technical literature and catalog cuts.

B. Shop Drawings:
   1. Submit installation shop drawings for the overall lightning protection system. Include physical layout of the equipment, mounting details, and relationship to other parts of the work.
   2. Submit detail drawings for each major component.
   3. Submit location, size, and material of grounding electrodes, and connection type.
   4. Submit roof adhesive data for air terminals mounted on single-ply roofing.

C. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply roofing material.

D. Copy of Owner’s UL Master Label Certificate.

E. Test Reports:
   1. Submit test reports of resistance to earth for each grounding electrode.
   2. Include in each test report date of test, soil moisture content, soil temperature, test operator, instrument or other test equipment used, electrode designation or location matching that on shop drawings and ground impedance in ohms.

F. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

G. Closeout Submittals:
   1. Project record documents:
      a. Record active location of lighting protection system components.
   2. Operation and maintenance data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventative maintenance instructions.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Lightning protection system materials:
      a. Consists of standard products by a manufacturer regularly engaged in production of lightning protection systems.
      b. UL Listed
   2. Lightning protection system installer: UL Listed.

B. Regulatory Requirements:
   1. Lightning protection system: Comply with NFPA 780, UL 96, and UL 96A.

C. Certifications:
   1. Furnish Owner with UL Master Label Certificate upon completion of installation providing proof that the lightning protection system is in compliance with UL 96 and UL 96A standards.

1.7 SEQUENCING

A. Coordinate installation of lightning protection with installation of other building systems and components, including supporting structures and building materials, metal bodies requiring bonding to lightning protection components, exterior and interior building finishes, and building roofing.

B. Approval is to be granted from roofing system provider for all attachment and penetration methods being used by lightning protection installer to prevent violation of roofing system warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thompson Lightning Protection Company

B. Harger Lightning Protection, Inc.

C. Erico International Corporation

D. Approved Equal

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. NFPA 780, UL 96.

B. Materials: Air terminals, main and cross-run roof conductors, bonding and down conductors, conductor fasteners, and connections:
   1. Class I for portions of buildings 75’ and less above ground.
   2. Class II for portions of buildings higher than 75’ above ground.
   3. Air terminals: Solid type with a safety tip.

C. ANSI/NEMA GR1 Grounding Electrodes: 3/4” x 10 ft long copper-clad steel ground rod.

D. Concrete-Encased Electrodes: As shown on drawings.

E. Ground Ring Electrode: As shown on drawings.

F. Ground Connectors:
   1. Bronze of the clamp type and bronze clamp accessories.
   2. Provide in accordance with the requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

G. Galvanic Compatibility of Materials:
   1. Air terminals, conductors, fasteners, and connectors shall be galvanically compatible with surfaces they are mounted to.
   2. Copper materials in all locations except where the use of aluminum materials is necessary for galvanic compatibility.
   3. Aluminum materials on copper roofs are not acceptable.
   4. Aluminum materials where mounted on aluminum roofing, siding, or other aluminum surfaces.
   5. Bimetallic fittings when joining metals that are not galvanically compatible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lighting protection to comply with UL 96A, NFPA 70, and NFPA 780. Conform to the most stringent requirement in NFPA 780.

B. Bond exterior metals including flashing, roof drains, vent stacks, fans, water pipes, metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical and mechanical equipment on roof to lightning protection system.

C. Bond lower end of exhaust ducts, vent stacks, etc., passing through roof.

D. Run bonding jumpers continuously horizontally or down from point of bond to point of connection to main conductor.

E. Make down conductors electrically continuous, with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Protect down conductors, where necessary, to prevent physical damage or displacement to the conductor. Use PVC Schedule 40 conduits. Provide conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

F. Conceal system conductors and interior conductors.

G. Notify Architect at least 48 h before concealing lightning protection system components.

H. Below-grade or concealed cable connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.

I. Exposed cable connections: Use approved mechanical connections.

J. Air terminals mounted on single-ply roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions.

K. Attach each down conductor to the grounding electrode by exothermic welding.

L. Provide grounding electrodes with top 12" below finished grade.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the present of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Apply for inspection by Underwriters Laboratories, Inc. (UL) to obtain UL Master Label Certificate.

B. Verify that lightning protection surge arrestor devices are installed on all incoming power and communications lines, in order to obtain UL Master label Certificate.

C. Test grounding system to ensure continuity prior to backfilling and paving: Check that resistance to earth does not exceed 25 ohms, measured by "Fall-of-Potential" method.

D. Make resistance measurements in dry weather not earlier than 48 h after rainfall.

E. Make visual inspection to verify that there are no loose connections that may result in high resistance joints, and conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.

END OF SECTION

SECTION 26 4300

SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 - General Electrical Requirements

B. Section 26 0526 - Grounding and Bonding for Electrical Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Provide Type 1 or Type 2 Surge Protective Devices (SPD) for the protection of AC electrical circuits formerly known as Transient Voltage Surge Suppression (TVSS) System. Provide high energy surge current diversion and be suitable for application in Type 1 and Type 2 environments.

B. Modes of Protection:
   1. Line to Ground, Line to Neutral and Neutral to Ground for services with a neutral
   2. For Services without a neutral, Line to Line and Line to Ground

C. Provide common and normal modes of protection.

1.4 REFERENCE STANDARDS

A. ANSI C62.33 IEEE Standard Test Procedures for Varistor Surge-Protective Devices

B. ANSI C62.35 IEEE Standard Test Methods for Avalanche Junction Semiconductor Surge-Protection Device Components

C. ANSI C62.41 Recommended Practice for Surge Voltage in Low-Voltage AC Power Circuits

D. UL 1449 Surge Protective Devices Fourth Edition

E. IEEE 587

F. FIPS PUB 94

G. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits

H. National Electrical Code – Article 285

I. National Fire Protection Association – NFPA 20, 70, 75, and 78

1.5 SUBMITTALS

A. Submit Shop Drawings for equipment provided under this Section.

B. Submit shop drawings and product information for approval and final documentation in quantities listed according to Conditions of the Contract. Transmittals shall identify customer name, customer location, and customer order number.

C. Submittals shall include UL 1449 Listing documentation to verify the following:
   1. Short Circuit Current Rating (SCCR)
   2. Voltage Protection Ratings (VPRs) for all modes
   3. Maximum Continuous Operating Voltage rating (MCOV)
   4. I-nominal rating (I-n) of 20kA
   5. Type 1 or Type 2 device as required by location or indicated on drawings
   6. VPR, MCOV, I-n, and Type 1 and Type 2 information is posted at www.UL.com under Certifications or any Nationally Recognized Testing Laboratory. SCCRs are posted in manufacturer's published documentation.
   7. UL data and visual inspection takes precedence over manufacturer's published documentation.

D. Provide shop drawings including manufacturer installation instruction manual and line drawings detailing dimensions and weight of enclosure, internal wiring diagram illustrating all modes of protection in each type of SPD required, wiring diagram showing field connections, and manufacturer's recommended wire and breaker sizes (if required).

E. Upon request, an un-encapsulated SPD module shall be presented for visual inspection, proprietary technology included. MOV type and quantity shall reflect kA ratings on cutsheets, verification of diagnostic monitoring, thermal and overcurrent protection, etc.

F. Provide 3rd party testing for single and repetitive surge current for both devices for the MCOV listed. Test reports to indicate successful device operation to 3,500 sequential surges at rated surge current without failure.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Acceptable manufacturers:
   1. Thomas and Betts Division of ABB, Current Technology
   2. Smiths Power, Transtector/LEA International
   3. Mersen Electrical Power

2.2 PERFORMANCE CHARACTERISTICS

A. Response time: < 5 nanoseconds for all modes of protection.

B. SPD shall bear the Mark of a Nationally Recognized Testing Laboratory and shall be Listed to Fourth Edition of UL 1449. "Manufactured in accordance with" is not equivalent to the Listing and does not meet intent of specification.

C. Post SPD and performance parameters at www.UL.com under Category Code: VZCA or any Nationally Recognized Testing Laboratory. Products or parameter without posting are not approved.

D. Minimum surge current capacity for Service Entrance units based on 8 x 20 microsecond current waveform:
   1. 200,000 A between each phase for line-to-line mode
   2. 200,000 A each phase for line-to-ground mode
   3. 200,000 A each phase for line-to-neutral mode
   4. 200,000 A for neutral-to-ground mode

E. Minimum surge current capacity for panelboard units based on 8 x 20 microsecond current waveform:
   1. 100,000 A between each phase for line-to-line mode
   2. 100,000 A each phase for line-to-ground mode
   3. 100,000 A each phase for line-to-neutral mode
   4. 100,000 A for neutral-to-ground mode

F. Sequential Surge Current Survivability:
   1. 3,500 sequential category surges without failure.

G. Current Rating:
   1. Rated for continuous current and AIC rating of equipment protected.

2.3 OPERATING CONDITIONS

A. Temperature range: -40°C to +50°C

B. Relative humidity range: 0 to 95%, non-condensing

C. Audible noise level: < 40 dBA at 5 ft

2.4 FABRICATION

A. SPD Modules:
   1. UL Labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. Protect suppression component of every mode, including N-G, by internal overcurrent and thermal overtemperature controls. SPDs relying on external or supplementary installed safety disconnects do not meet intent of specification.
   2. UL Labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Mater label and NFPA 780.
   3. Suppression components: Heavy-duty MOVs, selenium cells, or combination of both.
   4. Provide surge current diversion paths for all modes of protection: L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.
   5. Provide thermal overload protection of MOV circuit. Overcurrent fuse protection of MOV circuit is not acceptable.
   6. Provide service entrance SPD audible diagnostic monitoring by way of audible alarm.
   7. Provide service entrance SPD with 1 set of NO/NC dry contacts for alarm conditions.

8. Provide visual LED diagnostics including a minimum of 1 green LED indicator per phase, and 1 red service LED. Include an audible alarm with on/off silence function and diagnostic test function (excluding branch).
9. For service entrance applications, provide an integral UL Recognized disconnect switch.
10. Dedicated 60A breaker to serve as a means of disconnect for distribution SPDs.
11. SPD is to be mounted in its own NEMA-1 enclosure external to the equipment being protected. Leads are to be HPI SPD conductor, less than 5' and routed in metallic conduit.
12. Meet or exceed the following criteria:
    a. UL 1449 Listed Voltage Protection Ratings (VPRs) for 6kV 3000A testing as follows:

VOLTAGE	**L-N** **L-G** **N-G**	**L-L**
208Y/120V	650-800V	650-800V
480Y/277V	1100-1300V	1900-2100V

13. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	**Allowable System Voltage Fluctuation (%)**	**MCOV**
208Y/120	25%	150V
480Y/277	25%	320V

14. Provide warranty for a period of 10 yrs against workmanship and manufacturing defect.

B. Service Entrance:
1. Install 1 primary suppressor external to the service entrance in accordance with manufacturer instructions.
2. Install SPD on line or load side as shown on drawings.
3. Bond SPD ground to service entrance ground or panelboard ground.

C. Distribution Panelboards:
1. Install 1 suppressor external to each designated distribution panelboard.
2. Install surge suppression device in accordance with manufacturer instructions.

D. SPD High Performance Interconnect Cable (HPI):
1. Provide dual-shielded triple insulated multi-core power conductor cable specifically listed for SPD installations.
2. Low impedance approximately 25% of conventional pipe and wire for improved clamping voltage.
3. Conductor length is to be less than 5'.
4. Avoid 90 degree bends in conductors.

PART 3 - EXECUTION

3.1 APPLICATION OF SPD

A. Provide UL approved disconnect switch within the SPD as a means of service disconnect. A 100A breaker in the service entrance gear can be substituted for a direct connection only where the AHJ will not allow a direct feed from the bus to the SPD disconnect.

B. Provide independent means of servicing disconnect at Distribution, MCC, and Branch such that the protected panel remains energized. A 60A breaker (or larger) may serve this function. Provide breaker as recommended by Manufacturer for each application

3.2 INSTALLATION

A. Install per manufacturer's recommended practices.

B. Conductors are to be High Performance, Low Impedance (HPI) cable.

C. Provide short and straight conductors not exceeding 5 feet in length.

D. Input conductors twisted together to reduce inductance.

E. Avoid 90-degree bends in cable.

3.3 QUALITY ASSURANCE

A. Factory test system before shipment. Include quality control check, "Hi-Pot" tests at 2 times rated voltage plus 1,000 V, ground leakage tests, and calibration.

B. Manufacturer Qualifications: Engage a firm with at least 5 yrs experience in manufacturing surge protective devices.

C. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 yrs. When requested by Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with requirement.

D. Provide SPD compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

3.4 FIELD QUALITY CONTROL

A. Inspections before SPD startup:
   1. Visual Inspection:
      a. Verify installation per drawings.
      b. Verify phase, neutral, and ground conductors are properly sized and configured.
   2. Mechanical Inspection:
      a. Check connections for tightness.
      b. Check terminal screws, nuts and/or connectors for tightness.
   3. Electrical Inspection:
      a. Confirm input voltage.
      b. Confirm phase, neutral and ground connections are proper.

3.5 WARRANTY

A. Provide 10 yr manufacturer warranty.

END OF SECTION

SECTION 26 5100

LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 260000 - General Electrical Requirements

B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables

C. Section 260526 - Grounding and Bonding for Electrical Systems

D. Section 260533 - Raceway and Boxes for Electrical Systems

E. Section 260923 - Lighting Control Devices

1.2 DESCRIPTION OF WORK

A. Provide complete and fully operational lighting system per Contract Drawings and Specifications.

B. Luminaires shall be provided complete with necessary accessories for proper installation.

C. Catalog numbers shown in luminaire schedule are basic luminaire types. Additional features, accessories and options specified, scheduled or necessary for proper installation shall be included.

D. Provide lamps (LED boards, modules, drivers) for luminaires as recommended by luminaire manufacturer, unless noted otherwise.

E. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.

F. Work includes final aiming and focusing of luminaires under the direction of, and at a time designated by the Architect/Engineer/Lighting Designer.

1.3 REFERENCE STANDARDS

A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)

B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)

C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)

D. NECA 503 – Standard for Installing Fiber Optic Lighting Systems

E. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility

F. UL 676 – Underwater Luminaires and Submersible Junction Boxes

G. UL 773 - Plug-in Photocontrols for use with area lighting

H. UL 924 - Emergency Lighting and Power Equipment

I. UL 1574 – Track Lighting

J. UL 1598 – Luminaires

K. UL 1838 – Low Voltage Landscape Lighting Systems

L. UL 2108 – Low Voltage Lighting Systems

M. UL 2388 – Flexible Lighting Products

N. UL 2562 – Pendant Cable

O. UL 8750 – LED Light Sources for use in Lighting Products

P. ANSI C78.377 – Chromaticity

Q. IESNA LM-79 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

R. IESNA LM-80 - Approved Method: Testing Lumen Maintenance of LED Light Sources

S. IESNA TM21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources including Addendum A

T. IES Lighting Handbook – 10th Edition

U. IES RP-29 Lighting for Hospitals and Healthcare Facilities

1.4 QUALITY ASSURANCE

A. Luminaire and accessory components shall be constructed of materials appropriate for their use.

B. Luminaires, drivers, lamps and other components shall meet the requirements of all applicable State and Municipal codes and energy codes.

C. Provide luminaires listed and labeled by UL or other testing lab acceptable to local jurisdiction for their indicated use and installation conditions.

D. Contractor shall coordinate installation of lighting systems with all trades.
   1. Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Architect, Engineer, or Lighting Designer.
   2. Multiple Name Specification:
      a. When multiple manufacturers are listed, Electrical Contractor shall choose which of the listed products are to be provided.
      b. Products of the same type shall be of same manufacturer.
   3. Single Name Specification:

a. When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product or pre-approved alternate.

b. Specifier has secured accurate pricing for all single name products prior to bidding and has shared this information with Architect/Owner's Representative. Contractor shall supply contractor net unit pricing for all single name products specified. Unit price shall be for equipment only and not include installation or miscellaneous electrical costs.

4. Contractor shall coordinate and verify compatibility of luminaires with lighting control system

a. Control protocol indicated for luminaires matches protocol of lighting control system specified. Contractor shall coordinate and verify compatibility of all dimming luminaires with control system to ensure that dimming is flicker free, continuous dimming through the dimming range noted on the luminaire schedule.

E. Substitution requests:

1. Will be evaluated prior to Bid.
2. Shall follow procedures set forth in this Section under paragraph 1.7 and in Section 012500 - Substitution Procedures.
3. Shall be made not less than 10 days prior to bid date.
4. Shall include the following information indicating that the proposed substitution is of similar construction quality and assembly, lumen output and distribution, color temperature, color consistency, and controllability:

a. Specified and proposed manufacturer's product data sheet, noting options and features.

b. Provide dimensioned drawing of luminaire.

c. Provide photometric data in the form of an electronic IES file on USB or via email for use in a recognized computer lighting program.

5. Provide table-top working samples and/or mockup of specified luminaire and proposed alternate.
6. Samples shall:

a. Be fully operable, complete with specified lamp(s) and with functioning cord and plug ready for installation.

b. Remain available during construction.

c. Meet the requirements outlined in Section 1.8.

7. Electrical Contractor shall be responsible for all costs incurred by substitution request sample and/or mockup production and review.
8. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.
9. When requesting a substitution, Electrical Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended delta savings to owner to be realized by accepting proposed alternate. If requested, provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.

10. Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.
11. For all luminaire types using an LED light source, provide independently tested, IESNA LM79 compliant photometry testing data and IESNA LM-80 Lumen Maintenance data.

1.5 WARRANTY

A. Exit Signs Utilizing LED lamp Technology: Provide manufacturer's warranty for a period of not less than five years from the date of substantial completion including parts and labor for full replacement of defective product.

B. LED Luminaires: Provide Manufacturer's warranty for a period of not less than five years from the date of substantial completion or the specified warranty period greater than five years for repair or replacement of defective electrical parts, including light source and driver

C. Luminaires without integral LED sources: Provide manufacturer's warranty for a period of not less than one year from the date of substantial completion including parts and labor for full replacement of defective product.

1.6 SUBMITTALS

A. Electronic submittal shall be limited to the greater of 500 pates or 30 MB to ensure that all pages load correctly. Bookmarks by luminaire type are required for ease of navigation. Submittals exceeding these limits should be broken in a logical fashion into multiple volumes for separate review. Measures to reduce file size should not compromise legibility or any other factors affecting ease of review.

B. Upon award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including currently quoted lead times for product delivery. Should Electrical Contractor anticipate delivery schedule of any specified product may adversely impact construction schedule, they shall bring it to the attention of Owner/Architect/Lighting Designer at this time.

C. In addition to complying with requirements of Section 260000 - General Electrical Requirements, submittals shall include the following:
   1. Manufacturer's product data
   2. Installation instructions
   3. Maintenance data
   4. Parts list for each luminaire accessory
   5. Photometric Data: photometric data for luminaire, including optical performance as follows:
      a. Coefficients of utilization
      b. Luminance table
      c. Candela distribution data
      d. Zonal lumens
      e. Area and roadway luminaires shall include Isocandela Charts, IES Roadway Distribution Classification and IES BUG (Backlight – Uplight – Glare) ratings.
   6. Driver schedule indicating manufacturer, type, and catalog number for each luminaire

7. Driver cut sheet for each driver used, referencing luminaire type(s)
8. Lamp schedule indicating manufacturer, type, and catalog number for each luminaire
9. Lamp cut sheet for each lamp used, referencing luminaire type(s)
10. Documentation of LED and driver compatibility
11. Lighting Controls and LED Driver Compatibility Document
    a. Lighting control vendor must review and approve in writing each luminaire controlled by their system is compatible and will operate at full range of dimming. Lighting vendor responsible for providing lighting control vendor with LED driver technical specifications required to verify the lighting controls and LED driver compatibility. Contractor must submit a Lighting Controls and LED Driver Compatibility Document for Owner/Design Team review/approval.
12. Product color/finish
    a. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect/Engineer/Lighting Designer for selection.

D. Shop Drawings for equipment provided under this Section shall include the following:
1. Overall submittal drawings indicating luminaire size, mounting (including ceiling type), light source, shielding, and voltage attributes, as well as manufacturer's product data, installation instructions, maintenance data, and parts list for each luminaire.
2. Catalog cutsheets lacking sufficient detail will not be accepted.
3. Detailed drawings of linear pendant mounted and suspended luminaires including dimensions, support spacing, suspension type, power feed type and locations, lamp combinations, driver locations, wiring and controls configuration, luminaire joint locations and end plates. Provide canopy details that indicate coordination with the ceiling system provided.
4. Detailed drawings for each cove and linear wall system configuration including dimensions, power feed locations, driver locations, luminaire joint locations, extension plates for end and corner sections and end plates.
    a. For LED strip luminaires mounted in architectural coves, provide dimensioned drawings and sections and include accessory cut sheets as specified. Within coves, all luminaires are to be mounted end to end with no more than 12” unlit split evenly between ends
5. Detailed drawings for LED systems including LED color, color consistency, rated life, warranty, and scale plans with luminaire layout, number, type and location for drivers, and a complete bill of materials.
6. Detailed drawings for continuous recessed or continuous surface mounted LED luminaires including dimensions, power feed locations, driver locations/quantity, luminaire joint locations, extension plates for end and corner sections and end plates as applicable.
7. Detailed drawings for custom LED handrail systems including dimensions, power feed locations, driver locations/quantity, luminaire joint locations as applicable.
8. For LED luminaires, submit documentation that indicates specified products have been tested, or will be tested, for compatibility with the lighting controls being procured and will perform as specified. Control devices or system shall be able to control luminaires with flicker free, continuous dimming, in range specified. Electrical Contractor, luminaire manufacturer and lighting control manufacturer shall be financially responsible for any incompatibilities.

9. Detailed drawings for nonstandard/custom luminaires indicating dimensions, weights, method of field assembly, components, features, and accessories. Details shall be scaled to a legible size.
10. Drawings for site lighting shall include pole data with wind loading, complete dimensions and finish, pertinent physical characteristics and accessories including mounting details, driver type and location and any specified control options.
11. Photometric Data: Where indicated on luminaire schedule and Contract Drawings, supply complete photometric data for luminaire, including optical performance rendered by independent testing laboratory developed according to methods of the Illuminating Engineering Society of North America as follows:
    a. Coefficients of utilization
    b. Luminance table with data presented numerically, showing maximum luminaire luminance at shielding angles. Readings should be taken both crosswise and lengthwise in case of luminaire with an asymmetric distribution.
    c. Candela distribution data, presented graphically and numerically, in 5° increments (5°, 10°, 15°, etc.). Data developed for up and down quadrants normal, parallel, and at 11-1/2°, 45°, 67-1/2° to lamps if light output is asymmetric.
    d. Zonal lumens stated numerically in 10° increments (5°, 15°, etc.) as above.
12. No variation from the general arrangement and details indicated on drawings shall be made on shop drawings unless required by actual conditions. All variations shall be marked on drawings submitted for approval.

E. Provide luminaires with factory or field finish as directed by Architect/Engineer/Lighting Designer. Verify final finish requirements before releasing luminaires for fabrication.

F. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect for selection. Luminaires not having color or finish acceptable to Architect shall be replaced at no additional cost.

1.7 SAMPLES

A. Upon return of submittals, and prior to release for manufacturing, Contractor shall furnish one working sample of each luminaire for which sample requirement is noted in Luminaire Schedule.
    1. All requested samples shall be furnished as specified on luminaire schedule including but not limited to: light output, correlated color temperature, distribution, lens type and finish.

B. Shipping: Samples shall be complete with specified lamp(s) or LED module(s), cord and plug, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to Architect/Engineer/Lighting Designer or as otherwise advised.

C. Samples will not be returned, nor included in quantities listed for project.

D. Sample must be actual working unit.

E. All custom luminaires require a submission of material finish samples, component approval and a complete operating prototype luminaire. Prototype to be submitted prior to commencement of final luminaire fabrication and shall include specified lamps. Modifications may be required as a result of prototype review. These modifications and others that do not materially affect the cost of the luminaire shall be incorporated at no additional cost to Owner.

1.8 LUMINAIRE MOCK-UPS

A. Upon return of submittals, and prior to release for manufacturing, Contractor shall provide mock-up on site (or at another agreed upon location) in actual architectural conditions for review by Architect/Engineer/Lighting Designer and Owner.

B. Provide type and quantity of luminaires as requested by Architect/Engineer/Lighting Designer.

C. Mock-up shall include working luminaires and fastening devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Luminaires:
1. As shown on Luminaire Schedule

B. LED Drivers:
1. Shall be manufacturer recommended compatible driver.
2. All LED drivers shall be dimming type standard unless otherwise noted. Refer to construction documents for control per application.
3. Manufacturers must be compatible with lighting control system(s) provided and control luminaires from 100% to 1% light output or 100% to 10% light output per Luminaire Schedule and controls intent documents.

C. Emergency LED Drivers:
1. Bodine, Dual-Lite, Iota or as specified in the Luminaire Schedule

D. Low Voltage Transformers:
1. Q-Tran or as specified in the Luminaire Schedule

E. LED Modules:
1. Philips Lumileds, Xicato, Cree, GE, Nichia, Osram Sylvania, Bridgelux, Citizen or as specified in the Luminaire Schedule

2.2 FABRICATION AND MANUFACTURER

A. Luminaires:
1. Construction
a. Luminaires shall bear label indicating circuit voltage. Labels shall not be visible from normal viewing angles.
b. Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
c. Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
d. Surface temperatures of luminaires with integral drivers shall not exceed 90°C in 30°C ambient.

e. Luminaires recessed in ceilings utilized as air handling plenums shall be certified as suitable for the purpose and conform to NEC Article 300.

f. Miter cuts shall be accurate, joints shall be flush and without burrs.

g. LED troffers with doors shall have spring-loaded door cam latches.

h. Luminaires shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance documented. Low voltage transformers and drivers shall be vented per manufacturer's specifications.

i. Provide inscription for exit and stairway signs to conform to applicable codes.

j. Verify types of ceiling construction with General Contractor prior to releasing luminaires for fabrication and delivery and provide luminaires adapted to ceiling construction used.

k. Coordinate recessed luminaire mounting appurtenances, flanges and trims with construction of ceiling in which luminaire is to be recessed. Provide correct luminaire mounting assembly.

l. Luminaire frames shall be manufactured of non-ferrous metal or be suitably rust proofed after fabrication.

2. LED Luminaires are considered a lighting system with dependent components that must be evaluated as a complete system. Each LED luminaire includes a light emitting source, provisions for heat transfer, electrical control, optical control, mechanical support and protection, as well as aesthetic design elements. All LED luminaires shall:

a. Be UL listed or equivalent. Where remote drivers are specified, all drivers shall also have UL listing or equivalent and comply with code requirements.

b. Be tested to IESNA LM-79-08 testing using absolute photometry criteria.

c. Be rated at > or = to 70% lumen maintenance at 50,000 hours of operation.

d. Be rapid cycle stress tested.

e. Have integral lamp modules with a minimum operating temperature of -20°C.

f. Have lamp modules that are capable of being easily replaced upon failure with a manufacturer provided replacement module without voiding the UL listing of the luminaire.

g. Have driver housings easily accessible for ease of maintenance.

h. Have a maximum operating temperature at LED junction to not exceed 90°C over the expected operating range of the luminaire.

i. Be RoHS compliant, lead and mercury free.

j. Have an LED operating frequency of + or – 120 Hz.

k. Must meet the appropriate Federal Communications Commission (FCC) requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use)

l. Be Class A Sound rated.

m. Be supplied with power supply that complies with IEEE C. 62.41-1991.

n. Operate at 120 or 277 volts, ±10%.

o. Have reverse polarity protected at all hardwired connections and have high voltage protection in the event connections are reversed or shorted during the installation process.

3. Lenses, Reflectors and Diffusers

a. All lenses or louvers shall be removable, but held so that normal motion will not cause them to drop out.

b. All glass used in LED luminaires shall be made from thermal shock resistant borosilicate glass.

c. Optical lenses shall be free from spherical and chromatic aberrations.

d. Acrylic lenses shall be 100% virgin acrylic material.

e. Diffuser materials shall be UV stabilized in applications exposed to sunlight.

f. LED troffer lenses shall be 0.125” thick, unless otherwise noted.

g. Alzak reflectors and louvers shall be low iridescent equivalent to Coil Anodizers. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years.

h. Reflector cones shall not have visible lamp flashing in the cone.

4. Optics and Adjustments

a. Lamp holders shall be suitable for the indicated lamps and shall be set such that lamps are positioned in optically correct relation to all luminaire components.

b. Adjustable Angle Luminaire: Luminaires with adjustment beam angle shall contain reliable angle locking devices.

5. Finishes

a. Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.

b. Painted luminaires shall be painted after fabrication or "post painted".

c. Ferrous parts and supports shall be rust proofed after fabrication.

d. For weatherproof or vaportight installations, painted finishes of luminaires and accessories shall be weather resistant using proper primers or galvanized and bonderized epoxy, so that entire assembly is completely corrosion resistant for service intended and rated for an outdoor life expectancy of not less than 20 years.

6. Wiring

a. Luminaires shall be completely wired at the factory and as required by code.

b. Internal wiring shall contain no splices.

c. Connections shall be made with insulated "wire nut" type mechanical connectors except that driver connections shall comply with NEC Article 410.

d. Wire for connections to lamp sockets and lamp auxiliaries shall be minimum #16 AWG luminaire wire.

e. Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.

f. Recessed luminaires installed in inaccessible ceilings shall be UL listed for through wiring with the junction box accessible from the luminaire opening.

g. Provide dual-level switching for luminaires as indicated on luminaire schedule and/or where shown on Contract Drawings. Typically first switch designation controls outboard lamps, and second switch designation controls inboard lamp(s), unless noted otherwise.

h. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.

i. Provide lamps for all luminaires.

7. Ceiling Coordination

a. Verify type of ceiling construction prior to releasing luminaires for fabrication and delivery.

b. Provide mounting appurtenance, flanges, sloped ceiling adaptors where required.

c. Provide mounting assembly, clips or other mechanical mounting lugs as required for support of luminaires.

d. Coordinate light fixture trim paint color/finish to match the ceiling system. The same light fixture type may require multiple trim finishes due to installation in multiple ceiling systems and finishes.

8. Track-Lighting Systems:

a. A lighting track system is defined as a manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length may be altered by addition or subtraction of sections of track. Lighting track may be either flexible or rigid depending on the specific application.

b. Provide lighting track types as specified in Luminaire Schedule, in lengths as indicated on lighting plans.

c. All line voltage track lighting systems shall be provided with integral current limiters or be fed from supplementary overcurrent protection panels to limit power consumed by track.

d. Lighting track system includes current carrying conductors which may convey either line voltage (120V) or low voltages (12V or 24V). Characteristics of lighting track that conveys line voltages are different than a lighting track system that conveys low voltages and as such are governed by different requirements. Therefore, they are considered individually in these Specifications.

1). Line voltage (120V) Lighting Track systems:

a). Provide components, including track, fittings, and luminaires from the same manufacturer as recommended by manufacturer for the intended use. All components shall be UL Listed and comply with the National Electric Code Standards for Lighting Track.

b). Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of live and neutral conductors must always be maintained along continuous run so that track fittings connect into the track in a consistent manner.

c). Support lighting track at intervals recommended by the track manufacturer.

d). One or two circuit Lighting Track shall be supplied with separate neutral busbars and have the ability to have each circuit separately dimmed as required when using standard voltage and low voltage luminaires with either magnetic or electronic transformers.

e). Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run.

f). One and two circuit 120 volt Lighting Track shall be rated at 120/250 volt, 60 Hz, 2,400 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.

g). A separate grounding busbar shall be integral in all track lengths.

2). Low voltage (12V or 24V) Lighting Track systems:

a). Provide components, including track conductors, remote mounted transformers, fittings, and luminaires from the same manufacturer as

recommended by the manufacturer for the intended use. Components shall be UL Listed as applicable for low voltage use.

b). Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of conductors must always be maintained along continuous run so that track fittings connect into track in a consistent manner.

c). Support lighting track at intervals recommended by track manufacturer.

d). One and two circuit low voltage Lighting Track shall be supplied with three conductors and have the ability to have each circuit separately switched with either magnetic or electronic transformers provided by the track manufacturer. Two circuit low voltage Lighting Track can only be dimmed if both circuits are fed from the same transformer and as a result, separate circuit dimming shall not be attempted or permitted.

e). All transformers shall be supplied with both primary and secondary voltage over-current protection devices that shall remain readily accessible for maintenance and testing purposes.

f). Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run. Separate, single circuit transformers are required for each independently controlled circuit with the use of electrically isolated couplers.

g). Conductors used in low voltage Lighting Track shall be, at minimum, equivalent to #10 AWG 30 amp wire or heavier and be capable of carrying a 300 watt load (at 12 volts) up to 32 ft from transformer feed within range of luminaire voltage tolerance. At 24 volts, conductors shall be capable of supplying a 600 watt load up to 60 ft from transformer feed within range of luminaire voltage tolerance.

h). If taut strung cable conductors are used as low voltage Lighting Track system, they shall have a Kevlar core to prevent strain on outer current carrying conductors.

i). Only insulated type taunt strung cable conductors shall be used in order to comply with local electrical codes governing installation.

9. Outdoor Lighting Systems:
   a. Provide luminaires, mounting arms, brackets, poles, hand-hole covers, base components, and all other accessories for a complete assembly. Manufacturers shall be responsible for proper fitting of elements and structural integrity of unit
   b. Provide poles as shown on luminaire schedule.
      1). Poles shall have hand-holes.
      2). Fusing for each luminaire head shall be located in hand-hole near base of pole.
      3). Pole base anchor bolts shall be galvanized.
   c. Exterior Luminaires:
      1). Shall operate at a minimum ambient temperature of 0˚ F (-17˚C)
      2). Shall be fully gasketed, with UL wet location label.
      3). Shall have approved wire mesh screens for ventilation openings.
      4). Anodized aluminum reflectors shall have minimum of 0.00079” (0.02mm) anodizing thickness.
   d. Pole/luminaire combination shall have EPA rating that will withstand site wind conditions.

e. All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
f. Aluminum surfaces shall receive a duronodic or polyester powdercoat paint finish.
g. Cast-in luminaire housing installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
h. Where cast aluminum housing are used, give two coats of asphaltum paint prior to installation.
i. Provide 1/8” thick x 2” diameter (3 mm thick x 50 mm diameter) solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.3 DRIVERS

A. Drivers for use in cold or freezer rooms, parking structures, loading docks, and outdoors shall be low temperature type.
1. Driver shall be lowest temperature rating available in standard manufacture for its type.

B. Drivers shall be located in luminaire they serve, unless otherwise noted.

C. LED Drivers and Power Supplies shall:
1. Operate system LEDs within the current limit specification of the LED manufacturer.
2. Be supplied with over-temperature protection circuitry.
3. Be programmable to allow for LED replacement modules to be “tuned” to match the output of remaining adjacent modules in the event that some time has passed and there has been lumen depreciation.
4. Be within a NEMA enclosure.
5. Be equipped with knockouts to accommodate standard conduit sizes
6. Have a Power Factor to be = or > than 0.9
7. Have a Lamp Current Crest Factor < 1.5
8. Dimmable LED drivers must be compatible with dimming system(s) provided and control luminaires per luminaire schedule and controls documentation.
9. ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.
10. Class A sound rated
11. Equipped with resetting thermal sensitive device.
12. For operation at 60 Hz and voltage as scheduled.
13. Meet or exceed all ANSI or NEMA standards
14. Capable of operating LEDs with less than 5% flicker
15. Be DMX compatible in Color changing LED luminaires.

D. LED Data Enablers shall be:
1. Compatible with DMX.
2. NEMA enclosure.
3. Equipped with knockouts to accommodate standard conduit sizes.
4. Convection cooled.
5. RoHS compliant.

E. Emergency LED Drivers shall:
1. Be UL 924 listed
2. Operate LED luminaire at 10W minimum output for 90 minutes with efficacy equal to or greater than the normal power efficacy.
3. Have high temperature nickel-cadmium battery.
4. Be installed inside/on top off luminaires
5. Have solid state charging
6. Battery to be recharged within 24 hours
7. Remote battery test switch.

2.4 LOW VOLTAGE TRANSFORMERS

A. Transformers shall be:
1. Sized to compensate for voltage drop over indicated distances
2. Locally fused

B. Transformers shall have line voltage switch within reach.

C. Provide adequate ventilation to meet code and manufacturers requirements.

2.5 LAMPS

A. Provide lamps as noted on Luminaire Schedule.

B. Provide lamps of same type from same manufacturer.

C. Where a specific lamp manufacturer has been indicated in the Luminaire Schedule, lamps shall be supplied from named manufacturer only.

D. White LED sources shall be:
1. Minimum CRI of 90 unless noted otherwise on Luminaire Schedule
2. Less than 5% flicker
3. Within 0.004 on the CIE 1976 diagram for color spatial uniformity
4. Within 0.007 on the CIE 1976 diagram for color maintenance over the rated lifetime of the source
5. Binned within a 3-step MacAdam ellipse minimum, or as indicated in Luminaire Schedule
6. Color temperature as noted on Luminaire Schedule
7. Have a published life rating based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources and IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources
8. L70 rated life shall be a minimum of 50,000 hours.
9. LED modules, unless noted otherwise, shall be provided by light fixtures manufacturer and integral to luminaire.
10. Screw-base LED replacement lamps, where required and listed on the luminaire schedule, shall meet dimming, output, CCT and CRI as specified. 25,000 hours is acceptable L70 rated life for these products.

E. Provide all other lamp types and special purpose lamps as noted on Luminaire Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Marking:
1. Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.
2. Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when lamps are in place.

B. Installation of Luminaires:
1. Lamps, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
2. Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.
3. Light leaks between ceiling trim of recessed luminaires and ceiling are not allowed.
4. Locations
    a. Install luminaires at locations and heights as indicated.
    b. Do not scale electrical drawings for locations of luminaires.
    c. Architectural reflected ceiling plans show locations of luminaires.
    d. Where noted on the drawings, the exact location of luminaires shall be confirmed (in the field) with the Architect/Engineer prior to installation.
    e. Where luminaires are to be concealed, or surface mounted in highly visible public spaces, a small sampling of luminaires shall be installed, adjusted and aimed for Architect/Engineer's review approval, prior to installing remaining luminaire of same type.
    f. Mount all luminaires so as to maintain full range of motion.
    g. Install luminaires plumb, square, and level with ceilings and walls.
    h. Coordinate stem, rod, chain, or aircraft cable hanger lengths with job conditions. Provide extra length of adjustable supports where diffusers are mounted directly above light fixtures to facilitate air balancing efforts.
    i. Industrial type luminaires in unfinished areas, which are near obstructions such as ducts and pipes, shall be:
        1). Suspended so that bottom of luminaire is no higher than bottom of obstruction.
        2). Located at height of lowest luminaire
        3). Minimum height: 8’-0”
        4). Shall not be located until locations of obstructions are determined.
        5). Where a minimum height of 8’-0” is unachievable, wall mounted luminaires will be utilized.
5. Support

a. Support surface mount luminaires from building structure.
b. Metal decking shall not be pierced for luminaire support.
c. Provide luminaires and/or luminaire outlet boxes with hangers to support luminaire weight.
d. LED troffers shall be held in place by support clips.
e. Provide plaster frames for recessed luminaires in plaster ceilings.
f. Rigid metallic pipe stems shall be utilized for the support of pendant mounted luminaires, unless otherwise noted.
g. Stem hangers shall be equipped with aligner box covers or canopies so that stems hang vertically, irrespective of the angle of the surface they are mounted from.
h. Wherever a luminaire or its hanger canopy is attached to a surface mounted outlet box, a finishing ring shall conceal the outlet box.
i. Yokes, brackets and supplementary supporting members needed to mount luminaires to suitable ceiling members shall be furnished and installed by Contractor. Verify mounting hardware required prior to installation.
j. Recessed luminaires shall be supported with 12 ga wire hangers, 2 per luminaire, at diagonally opposite corners.
k. Recessed LED troffers and luminaires over 55 lbs, such as 4' x 4' shall be supported with 12 ga wire hangers, 4 per luminaire, 2 at 45 degree diagonals, and two perpendicular to structure. Wire hangers and attachment to structure shall be capable of supporting 4 times luminaires weight.
l. Surface luminaires installed in grid ceilings shall be supported by independent support clips and 12 ga wire.
m. Exit signs installed in grid ceilings shall be supported by electrical box hanger and additional 12 ga wire installed from box to structure.
n. Support surface mounted luminaires greater than 2 ft in length at a minimum of each additional 2 ft, or as recommended by manufacturer.
o. Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.
p. Rigidly align continuous rows of luminaires.
q. Luminaire types with remote mounted driver shall have:
   1). Proper support for driver weight.
   2). Mounting distance from remote driver to luminaire per manufacturer's recommendations.

6. Mounting and Enclosures
   a. Install flush mounted luminaires to eliminate light leakage.
   b. For luminaires mounted adjacent to insulation, provide barrier to prevent insulation from coming in contact with luminaire, unless luminaire is approved for installation in contact with such insulation.
   c. Provide approved fire rated enclosures around luminaires in fire rated ceilings.
7. Conduit and Wiring
   a. Wire for connections to lamp sockets and auxiliaries shall be suitable for temperature, current, and voltage conditions.
   b. Recessed luminaires shall have final connections made with flexible metal conduit, not in excess of 72", with THHN conductors and green wire ground conductor.

c. Conduit shall be hidden from normal view in all possible cases. In public areas where surface mounted conduit must be used, contractor shall install conduit as unobtrusively as possible. Contractor shall obtain field approval by the architect for all exposed conduit runs prior to rough in.

8. In-Grade Luminaires:
   a. Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.
   b. Provide adequate drainage system per manufacturer's recommendations.

C. Installation of Outdoor Pole Bases
1. Contractor shall provide bases for luminaires.
2. Pole base details shall be provided by the project structural engineer.
3. Provide handhole for electrical connection within 4’-0” of pole base.
4. Contractor shall:
   a. Rough-in conduits
   b. Coordinate spacing, base dimensions, heights, orientation of bases, etc. as necessary.
5. Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Architect/Engineer/Lighting Designer.

D. Pole Installation:
1. Install luminaires, poles, hardware, etc., for complete system.
2. Use web fabric slings (not chain or cable) to raise and set poles.

E. Grounding:
1. Ground luminaires and metal poles according to Division 26 Section "Grounding and Bonding for Electrical Systems".
2. Poles:
   a. Install 10 ft driven ground rod at each pole.
3. Nonmetalic Poles:
   a. Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with #10 AWG conductor.

F. Spare Parts:
1. Provide spare globes and guards, 1 for every 100 of each type and rating installed. Furnish at least one of each luminaire family.
2. Provide spare louvers and reflector cones, 1 for every 100 of each luminaire family. Furnish at least one of each type.
3. Provide spare plastic diffusers and lenses, 1 for every 100 of each luminaire family and rating installed. Furnish at least one of each type.
4. Furnish one spare custom luminaire for each 10 supplied.
5. Provide 1% spare replaceable LED lamp modules for each primary fixture series type in Luminaire Schedule
   a. Spare LED lamp modules shall be delivered to Owner in new condition and in original packaging.

b. Manufacturer and model number shall match those installed in the project's luminaires.

6. Provide spare LED drivers, 1 for every 100 of each primary fixture series type and rating installed. Furnish at least one of each type.
   a. Manufacturer and model number shall match those installed in the project's luminaires.
7. Provide 1% spare LED luminaires with non-replaceable lamp modules consisting of entire LED luminaire assembly and driver(s).

3.2 SUBSTANTIAL COMPLETION

A. Quality Control:
1. At Date of Substantial Completion, replace lamps/LED modules/LED luminaires which are not operating properly.
2. Protection wrapping on lensed or louvered luminaires shall be removed before installation of furniture, but after finish work is complete.
3. Deliver spare equipment to Owner's representative.

B. Tests:
1. Give advance notice of dates and times for field tests.
2. Provide instruments to make and record test results.
3. Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized.
4. Verify operation of luminaires with lighting control system and daylight harvesting systems. Any dimmed fixtures shall exhibit no signs of flickering.
5. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
6. Report results of tests.

C. Adjusting and Cleaning:
1. Clean luminaires of handling marks, dust and dirt.
2. Cleaning and touch-up work shall be performed in accordance with luminaire manufacturer's recommendations.
3. Damaged luminaires or components shall be replaced with new.
4. Keep luminaires clean and protected for remainder of construction period.
5. Verify orientation of directional luminaires prior to installation.
   a. This includes wall washers, cove lighting, floodlights, exterior area lights and adjustable accent luminaires. Contractor shall provide electrician's services to aim, adjust, and focus luminaires, as required, at direction of Architect/Lighting Designer. These electricians shall be available at times designated by Architect/Lighting Designer and shall be provided at no extra charge to Owner over base bid. Contractor shall provide equipment for luminaires' focus including ladders and mechanical lifting systems.
6. Program preset dimming system lighting levels per direction from Owner/Architect/Engineer/Lighting Designer. Submittal process must include Contractor request for preset setting levels.

7. Program ambient light sensors integral to luminaires for appropriate illumination levels as indicated in control narrative or in lighting control specifications.
8. Program occupancy sensors integral luminaires for appropriate time delay as indicated in control narrative or in lighting control specifications.
9. Exterior poles, bollards, bases and other exterior luminaires shall be painted to match factory color where finish has been damaged.
10. No light leaks shall be permitted at ceiling line from any visible part or joint.

D. Training

1. Contractor shall provide Owner with 3 complete hard copies and 1 digital copy of Operations and Maintenance manuals
   a. All “Approved as Noted” comments shall be corrected/picked-up in this record manual set.
   b. Each manual shall contain specific information pertaining to the equipment installed. Each manual shall contain at a minimum:
      1). Detailed as built shop drawings for all lighting equipment installed.
      2). Manufacturer’s product cut sheets for all equipment installed keyed by type as to as built drawings.
      3). Manufacturer’s complete installation instructions for all equipment installed keyed by type to as built drawings.
      4). Equipment maintenance requirements and schedules.
      5). Equipment manufacturer contacts.
      6). Equipment manufacturer warranties.
         a). Luminaires
         b). Control gear/drivers
         c). Lamps/LED modules
2. Contractor shall provide qualified personnel onsite to provide a minimum of three days of training to Owner's representatives.
3. This training shall cover:
   a. Luminaire use and maintenance
   b. Architectural lighting system use and maintenance
   c. LED lighting systems that contain field replaceable components (LED boards, modules, drivers.
   d. LED lighting systems which are disposable technology where the entire fixture must be replaced, no field replaceable components.

END OF SECTION

SECTION 270501 - GENERAL PROVISIONS - COMMUNICATIONS

PART 1 - GENERAL

1.1 The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

1.2 Each Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.

1.3 The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating Electrical Systems indicated on the drawings and/or specified herein.

1.4 Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.5 It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime contract, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect (if applicable), then to the Engineer.

1.6 This section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

1.7 It is the intent of this Contract to deliver to the O a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.

1.8 In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to comply with this requirement may result in complete work stoppage by the Contractors

involved until a complete schedule of interruptions can be developed. Contractor will not be entitled to additional compensation due to work stoppage mandated by unscheduled interruption.

1.9 Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work. The contractor shall abide by the requirements on the Special Conditions and the University's outage request program.

1.10 Definitions:

1.10.1 Prime Contractor - The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.

1.10.2 Electrical Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, intercom, fire detection and alarm, security, video, etc.

1.10.3 Electrical Sub-Contractor - Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.

1.10.4 Low Voltage Contractor - Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

1.10.5 Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

1.10.6 Architect - The Architect of Record for the project, if any.

1.10.7 Furnish - Deliver to the site in good condition.

1.10.8 Provide - Furnish and install in complete working order.

1.10.9 Install - Install equipment furnished by others in complete working order.

1.10.10 Contract Documents - All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to: Plans, Specifications, Addenda, Instructions to Bidders, (both General and Sub-Contractors), Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Construction Manager's Assignments, Architect's Supplemental Instructions, Periodical Payment Requests, etc.

1.11 Note: Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

PART 2 - INTENT

2.1 It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

2.2 Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

PART 3 - DRAWINGS AND SPECIFICATIONS

3.1 The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.

3.2 The drawings and specifications are intended to supplement each other. No Contractor or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

3.3 The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

3.4 This Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

3.5 The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.

3.6 Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

3.7 Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

3.8 The drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

3.9 The Low Voltage Contractor and his Sub Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, electrical, etc.). Review all

drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.

3.10 Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

PART 4 - EXAMINATION OF SITE AND CONDITIONS

4.1 Each Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.

4.2 Each Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

4.3 The Low Voltage Contractor is required to provide coordination drawings, data and collaboration for all aspects of his work in accordance with the general and special conditions – Divisions 20, 22, 23, 26 and 28 the Construction Manager’s procedures.

PART 5 - EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

5.1 When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility.

5.2 References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of paragraph (A) immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten days prior to bid date for approval to bid in written form thru addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

5.3 Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the engineers.

5.4 Each Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.

PART 6 - SUPERVISION OF WORK

6.1 Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

PART 7 - CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

7.1 The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

7.2 Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

7.3 The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.

7.4 All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, owners private utility standards and with the requirements of all governmental agencies or departments having jurisdiction.

7.5 All material and equipment for the low voltage systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.

7.6 All low voltage work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the University Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.

7.7 The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.

7.8 Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring

methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

PART 8 - COST BREAKDOWNS

8.1 Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted.

PART 9 - GUARANTEES AND WARRANTIES

9.1 Each Contractor shall unconditionally guarantee all equipment, apparatus, materials, and workmanship entering into this Contract to be the best of its respective kind and shall replace all parts at his own expense, which fail or are deemed defective within one year from final acceptance of the work by the Engineer. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Engineer as being substantially complete.

9.2 Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

PART 10 - INSPECTION, APPROVALS AND TESTS

10.1 Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

10.2 The Contractor shall provide as a part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.

10.3 The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

10.4 Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

10.5 Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

10.6 Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

10.7 The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

PART 11 - CHANGES IN WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 12 - CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 13 - SURVEYS, MEASUREMENTS AND GRADES

13.1 The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

13.2 The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

13.3 Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

PART 14 - TEMPORARY USE OF EQUIPMENT

14.1 The permanent electrical equipment, when installed, may be used for temporary services, subject to and owner consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.

14.2 Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

PART 16 - RECORD DRAWINGS

16.1 The Contractor shall insure that any deviations from the design are being recorded daily or as necessary on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer at the completion of the work.

PART 17 - MATERIALS AND WORKMANSHIP

17.1 All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by technicians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

17.2 All conduit and/or conductors shall be concealed in or below walls, floors or above ceilings unless otherwise noted. All devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.

17.3 All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.

17.4 Each length of conduit, wireway, duct, conductor, cable, fitting, and device used in the electrical systems shall be stamped or indelibly marked with the makers mark or name.

17.5 All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

PART 18 - QUALIFICATIONS OF WORKMEN

18.1 All contractors bidding this project must have been a licensed company for a minimum of three years to qualify to bid this project. Individual employee experience does not supercede this requirement.

18.2 All low voltage contractors bidding the electrical work must have completed one project of 70% this contract cost size and two projects of 50% this subcontract cost size.

18.3 All work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

18.4 Special electrical systems, such as Fire Detection and Alarm Systems, Telecommunications or Data Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer,

within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

PART 19 - CONDUCT OF WORKMEN

19.1 The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

PART 20 - COOPERATION AND COORDINATION BETWEEN TRADES

20.1 The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be affected.

20.2 Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements.

PART 21 - PROTECTION OF EQUIPMENT

21.1 The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor.

PART 22 - SMOKE AND FIRE PROOFING

22.1 The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

PART 24 - FINAL CONNECTIONS TO EQUIPMENT

24.1 The roughing-in and final connections to all network connected equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturer’s representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (elevators, BMS panels, etc.)

PART 25 – NOT USED

PART 26 - ACCESSIBILITY

26.1 The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

26.2 The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

26.3 Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.

26.4 Access Doors; in Ceilings or Walls:

26.4.1 In mechanical, electrical, or service spaces:

14 gauge aluminum brushed satin finish, 1" border.

26.4.3 In finished areas:

14 gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.

26.4.3 In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

PART 27 - NOT USED

PART 28 - NOT USED

PART 29 - CUTTING AND PATCHING

29.1 Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

29.2 No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

PART 30 - SLEEVES AND PLATES

30.1 Each Contractor shall provide and locate all sleeves and inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved

methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

30.2 Sleeves shall be provided for all conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction. Sleeves shall not be provided for piping running embedded in concrete or insulating concrete slabs on grade, unless otherwise noted.

30.3 Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be packed with oakum and lead, mechanical waterstop or other approved material and made completely water tight by a method approved by the Engineer and/or Architect.

30.4 Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

30.4.1 Terminate sleeves flush with walls, partitions and ceiling.

PART 31 - WEATHERPROOFING

31.1 Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

31.2 Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

PART 32 - OPERATING INSTRUCTIONS

32.1 Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

32.2 Each Contractor shall furnish three complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

32.3 Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

PART 33 - SCAFFOLDING, RIGGING AND HOISTING

33.1 The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

PART 34 - CLEANING

34.1 The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible or all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

34.2 After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

PART 35 - PAINTING

35.1 Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

PART 36 - INDEMNIFICATION

36.1 The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

PART 37 - HAZARDOUS MATERIALS

37.1 The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

37.2 CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

37.3 If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

37.4 The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

PART 38 – ABOVE-CEILING AND FINAL PUNCH LISTS

38.1 The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project.

38.1.1 For review of the above-ceiling work that will be concealed by tile or other materials well before substantial completion.

38.1.2 For review of all other work as the project nears substantial completion.

38.2 When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list and all work prior to the ceilings being installed and at the final punch list review.

38.3 If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of $125.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.

PART 39 APPENDIX APPROVED MATERIALS LIST:

Horizontal Cabling		
UTP 4/24 Category 6 PVC Cable (Green)	Amp	1-219560-4
F/UTP 4/24 Category 6A PVC Cable (Green)	Amp	4-1499389-2
Horizontal Termination Hardware		
6 Port Faceplate	Amp	557691-X
4 Port Faceplate	Amp	558088-X
2 Port Faceplate	Amp	557505-X
Cat 6 Modular Outlet	Amp	1375055-X
Cat 6A XG Shielded Modular Jack	Amp	1711342-2
Blank Inserts	Amp	406339-X
Green Data Icons	Amp	558198-3
Modular Furniture Faceplate (confirm opening size with furniture supplier)		
Back Box for Data Outlet 4 11/16" x4 11/16" x2 1/8"	Steel City	72171-1
Back Box for Cat 6A Outlets 5" x5"x2 7/8"	Randl	
24 Port Category 6 Patch Panel	Amp	1375014-1
48 Port Cat 6A XG Angled Patch Panel	Amp	1933322-2
Horizontal Cable Mngmnt Panels 1 RMS	Panduit	CMPH1

7" Blank Panel Kit	Amp	556965-4
300 pr 110 Block Kit w/ legs	Amp	569446-1
100 pr 110 Block Kit w/legs	Amp	569440-1
Rack Mount 100 Pr 110 Block	Amp	558635-1

X = coordinate color of faceplates, modular outlets, and blanks (all same color) with the end user and electrical faceplates (if not stainless steel).

Copper Backbone Cabling

300 pr UTP Riser Cable	General Cable	2133373
200 pr UTP Riser Cable	General Cable	2133323
100 pr UTP Riser Cable	General Cable	2133144
25 pr UTP Riser Cable	General Cable	2133033
900 pr OSP Armored 24 AWG	General Cable	7525876
600 pr OSP Armored 24 AWG	General Cable	7525868
300 pr OSP Armored 24 AWG	General Cable	7525843
25 pr OSP Armored 24 AWG	General Cable	7525785

Optical Fiber Cabling and Termination Hardware

24 Strand OFNR Fiber Cable SM	Corning Cable Systems	024R81-33131-24
24 Strand OFNR Fiber Cable 62.5 MM	Corning Cable Systems	024K81-33130-24
24 Strand OFNR Fiber Cable OM3 MM	Corning Cable Systems	024S81-33180-24
12 Strand OFNR Fiber Cable SM	Corning Cable Systems	012R81-33131-24
12 Strand OFNR Fiber Cable 62.5 MM	Corning Cable Systems	012K81-33130-24
12 Strand OFNR Fiber Cable OM3 MM	Corning Cable Systems	012S81-33180-24
6 Strand OFNR Cable MM	Corning Cable Systems	006K81-31130-24
Outdoor Hybrid Fiber 48MM/48SM	Corning Cable Systems	096XW4-141XXA20
Outdoor Hybrid Fiber 24MM/24SM	Corning Cable Systems	048XW4-141XXA20
Outdoor Hybrid Fiber 12MM/12SM	Corning Cable Systems	024XW4-141XXA20
Outdoor Hybrid Fiber 6MM/6SM	Corning Cable Systems	012XWR-141XXA20
1” Innerduct (orange)		
Fiber Connector Housing Pretium®	Corning Cable Systems	PCH-04U
Fiber Connector Housing Pretium®	Corning Cable Systems	PCH-02U
Fiber Connector Housing Pretium®	Corning Cable Systems	CCH-01U
Connector Housing Panels (12 SM fiber)	Corning Cable Systems	CCH-CP12-59
Connector Housing Panels (12 MM fiber)	Corning Cable Systems	CCH-CP12-91
Connector Housing Panel (12 LOMMF)	Corning Cable Systems	CCH-CP12-E6
Connector Housing Panels (6 SM fiber)	Corning Cable Systems	CCH-CP06-59
Connector Housing Panels (6 MM fiber)	Corning Cable Systems	CCH-CP06-91
Fiber SC Unicam Connector MM	Corning Cable Systems	95-000-41
Fiber SC Connector SM	Corning Cable Systems	95-200-41
Fiber SC Connector LOMMF	Corning Cable Systems	95-050-41-X
Buffer Tube Fan Out Kit	Corning Cable Systems	

Telecommunications Room Racks

7' floor rack	Ortronics	Mighty Mo

12” Universal Cable Tray	Zero PFT	LR1012J
<u>Cable Tray</u>		
4” deep Cable Tray (6” rung spacing)	Monosystems	
Horizontal Elbows, Vertical Risers, Ts, Radius Drop Out		
Connection components		
<u>Surface Raceway – Metal Only</u>		
Size to be determined	Wiremold	
<u>Protection</u>		
Terminal Protection Block 100 pr	Marconi	R-355
Solid State Protector Modules	Corning Cable Systems	6SPE-BT
Bldg Entrance Protector Panel (100 pr)	Avaya	489BCB1-100
Solid State Protector Module	Avaya	4C1S
<u>Infrastructure Splice Components</u>		
Splice Closure	Preformed	8000635
Splice Closure End Plate Kits	Preformed	800081098
MS ^{2} Splicing Module (Dry)	3M	4000-D/TR
MS ^{2} Splicing Module (Filled)	3m	4000-D

END OF SECTION 270501

SECTION 270503 - SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

1. SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, seven sets of shop drawings and/or manufacturer's descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

Raceways

- Cable tray and each type of cable tray fitting.
- Surface-mounted metal or plastic raceways, with each type of fitting.
- Backboxes

- Floor box and poke-thru, activation plates each by type, with required accessories.
- Data/voice/video wallplates, each by type.
- Any special items not listed above.

Systems

Note: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Include system specific wiring schematics showing each device and its specific interconnect/wiring requirements. For rack mounted equipment, provide a scalable elevation drawing with proposed component locations & specific interconnect wiring requirements for each component/panel. Also provide scale building specific layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.

- Data network.
- Television Distribution System

Miscellaneous

- Control panel assemblies.
- Non-standard junction/pullboxes.

2. SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

3. MAINTENANCE AND OPERATION MANUALS

A. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:

- The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
- Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- The operating manual should contain the following information:

I. General Information
   a. Building function

b. Building description
c. Operating standards and logs

II. Technical Information
a. System description
b. Operating routines and procedures
c. Seasonal start-up and shutdown
d. Special procedures
e. Basic troubleshooting

- The maintenance manual should contain the following information:

I. Equipment data sheets
a. Operating and nameplate data
b. Warranty

II. Maintenance program information
a. Manufacturer's installation, operation, and maintenance instructions
b. Spare parts information
c. Preventive maintenance actions
d. Schedule of actions
e. Action description
f. History

- Test reports document observed performance during start-up and commissioning.

END OF SECTION 270503

SECTION 270508 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

PART 1 - COORDINATION

1.1 The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

1.2 Special attention to coordination shall be given to points where raceways, etc., must cross other ducts or conduit, and where conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

1.3 If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

PART 2 - INTERFACING

2.1 Each Electrical Trade, Specialty Trade, Mechanical Trade and the General Trades, etc., shall insure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

2.1.1 Coordination of connection of Telecommunications (voice, video, data) lines to Owner's existing or new services.

2.1.2 Connection to equipment furnished by other trades.

2.1.3 Electrical power connections to electrically operated (or controlled) equipment.

PART 3 - CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

3.1 Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

3.2 All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

3.3 Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

3.4 Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

3.5 For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

3.6 The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

END OF SECTION 270508

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

E. BMG: Building main grounding busbar

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

a. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.7 COMMISSIONING: This section specifies a system or a component of a system being commissioned as defined in Section 01 9100 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 01 9100 Commissioning for detailed commissioning requirements.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-B.

2.2 CONDUCTORS

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. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 2 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: #2 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor per drawings.
5. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. 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. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.
4. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Rack and Tray Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

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. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper in cross section and length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper in cross section and length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19 inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

E. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

F. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with J-STD-607-B.

3.3 APPLICATION

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, AWG minimum.

C. 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.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.)

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.
4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMBG and the ac service equipment ground shall be as indicated on the drawings.

3.5 GROUNDING BUSBARS

A. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Primary Protector: Bond to the TMGB with insulated bonding conductor.

D. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor shall be as indicated on the drawings.

E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

F. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

G. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

1. Waveguides and Coaxial Cable:

    a. Bond cable shields at the point of entry into the building to the TGB and to the cable entrance plate, using No. 2 AWG bonding conductors.
    b. Bond coaxial cable surge arrester to the ground or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 System functional performance testing is part of the Commissioning Process as specified in Section 01 9100. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

END OF SECTION 270526

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable trays.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Drawings for specific requirements for sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAYS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mono Systems, Inc. or comparable product.

B. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 6 inches o.c.
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 4 inches.
8. Width: 12 inches, 18 inches, or 24 inches as indicated on Drawings.
9. Fitting Minimum Radius: 12 inches.
10. Class Designation: Comply with NEMA VE 1, Class 12C.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 MATERIALS AND FINISHES

A. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 5052-H32 or Alloy 6061-T6] according to ANSI H 35.1/H 35.1M for fabricated parts.
2. Hardware: Chromium-zinc-plated steel, ASTM F 1136.

2.4 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, radius drops, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2 and UK CNS Standards.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

H. Place supports to provide clearances shown on Drawings.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze form as required by application.

J. Locate and install supports at each end connection and at mid-span. Support interval shall not exceed 6 feet.

K. Support trapeze hangers trays with 3/8-inch diameter rods.

L. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

N. Make changes in direction and elevation using manufacturer's recommended fittings.

O. Make cable tray connections using manufacturer's recommended fittings.

P. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

R. Install cable trays workspace per UK CNS Standards. Tray to have 12” clearance above, 26” to one side, and 6” below.

S. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to TIA/EIA 607 and UK CNS Standards unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communication." Bonding conductor shall be a minimum of #2 copper.

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm). Factory radius drops shall be used for all transitions in elevation.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Physically and electrically connect pathways to cable trays per UK CNS Standards and drawings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and 270010 “Supplemental Requirements for Communications” apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for labels and signs.
2. Labels.
3. Signs.
4. Cable ties.

B. Related Requirements

1. Refer to Section 260553, “Identification for Electrical Systems” for additional requirements related to labeling of electrical equipment and cabling.

1.3 REFERENCES

A. Definitions

1. Identifier: An item of information that links a specific element of the telecommunications infrastructure with its corresponding record.

B. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. Underwriters Laboratories Inc (UL)

a. UL 969, “Marking and Labeling Systems”

1.4 SUBMITTALS

A. Product Data: For each product type.

B. Identification Schedule: System Labeling Schedules with proposed designations for cables, outlets, terminations, and equipment.

1.5 COORDINATION

A. All identifications shall be consistent with the owner's standard practices, especially within existing facilities, unless otherwise require by codes. Where the requirements herein are in conflict, the contractor shall notify the engineer in writing prior to ordering any material.

B. All room names and/or numbers for labeling or programming shall use the Owner's approved room name and numbering scheme, not names and numbers indicated on floor plans. All reprogramming shall be included as required to accommodate construction phasing.

C. Coordinate with Owner for approval of all labelling codes and schemes prior to creation and installation of labeling system.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Comply with NFPA 70 and TIA 606 for a Class 2 system.

B. Comply with UL 969 for Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Labels shall be designed to remain permanently affixed and shall not fade under typical environmental conditions for the life of the product identified.

D. Thermal Movements: Allow for thermal movements from ambient temperatures up to 120-deg F and surface temperatures up to 180-deg F.

E. Provide mechanically printed black letters on a white field unless noted otherwise.

F. 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
2. Brother
3. Dymo
4. HellermanTyton
5. Panduit

2.2 LABELS AND TAGS

A. Heat Shrink Tubes: Flame-retardant shrinkable polyolefin tube with thermal transfer-printed identification label. Sized to suit diameter of cable and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F.

B. Self-Adhesive Labels: Thermal transfer-printed, minimum 3-mil- thick, flexible labels with acrylic pressure-sensitive adhesive.
1. Wraparound Vinyl or Nylon Cloth Type: Repositionable for wrapping and flagging flexible cables.
2. Self-Laminating Vinyl Type: Clear wrap around tail shield laminates the entire printed legend for abrasion, UV-, weather- and chemical-resistance on flexible cables.

3. General Purpose Polyester Type: for component labelling on flat surfaces.

C. Marker Plate Tags: Thermal transfer printed, UV, weather, and chemical resistant polyolefin suitable for large cables or bundles. Pre-punched holes for attachment with cable ties.

2.3 SIGNS AND NAMEPLATES

A. Engraved Plastic Signs and Nameplates:

1. 3-layer melamine plastic laminate
2. Weather and UV-resistant for Wet and Damp Locations.
3. Thickness:

    a. For signs up to 20 sq. in., minimum 1/16 inch thick.
    b. For signs larger than 20 sq. in.or 8 inches in length, 1/8 inch thick.
    c. Engraved designation with black letters on white face
    d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting. Exception for locations where specifically approved contact type permanent adhesive may be used where screws cannot or should not penetrate substrate.
    e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system suitable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs:
1. Self-tapping, stainless-steel screws, or stainless-steel machine screws with nuts and flat and lock washers.
2. Pop-Rivets.
3. Two-Part Epoxy Adhesive

C. Cable Ties: Self-extinguishing, one-piece, self-locking, UV-stabilized or plenum rated where required by installed environmental conditions. 3/16-inch minimum width.

PART 3 - EXECUTION

3.1 CABLING ADMINISTRATIVE DRAWINGS

A. Provide professionally produced, scaled drawings using Computer Aided Design software identifying the location and labelling of Communications devices served out of each telecom room.

B. Print on Arch D or E1 size paper and install in a prominent location in each equipment room and wiring closet so as not to interfere with future equipment installation.

C. Provide rigid frame and 1/8-inch clear plastic protective overlay.

D. Supply separate drawings for each Communications Room.

3.2 INSTALLATION

A. Mechanically produce all labels. Write-on labels are not permitted.

B. Install identifying devices before installing acoustical ceilings or similar concealment.

C. Verify identity of each item before installing identification products.

D. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond using materials and methods recommended by manufacturer of identification product and manufacturer of substrate to retain product warranties.

E. For surfaces that require a finish, apply identification devices to surfaces after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Install all labels in a neat manner, plumb and parallel to equipment lines.

H. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

I. Provide labels within 12-inches from cable termination points and secure tight to surface at a location with high visibility and accessibility for ease of identification after termination.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Equipment Room Racks, Cabinets, and Frames:

1. Identify top and bottom, front and rear of each with self-adhesive engraved laminated plastic nameplate containing rack or cabinet identifier (xy).
2. Label Size: minimum 2-inches in height with letters no less than 1-1/2-inches tall.

C. Rack Patch Panels and Fiber Enclosures:

1. Label each fiber enclosure and patch panel with a letter (-r) designating the order of the panel from the top of the cabinet or frame.
2. Label each fiber enclosure adapter panel with self-adhesive label indicating range of port numbers.
3. Label fiber enclosure cover with self-adhesive labels indicating each backbone cable link identifier including:

    a. Near end port numbers
    b. Far end building identifier (b) for inter building cable
    c. Far end Telecomm space identifier (fs)

d. Far end rack identifier (xy)
e. Panel identifier (-r)
f. Panel port numbers (:p)

4. Label each patch panel port or group of ports with a self-adhesive label or manufacturer provided insert indicating the following:

a. Room number of outlet being served.
b. Faceplate number.
c. Patch panel port number

5. Use manufacturer provided labels and mounting surfaces wherever possible.

D. Wall Punch down Blocks
1. Label each cable termination position with a sequential number designator.
2. Where insert type labels are used, install clear plastic cover over mechanically produced labels.
3. Use manufacturer provided labels and mounting surfaces wherever possible.

E. Backbone Cables:
1. Label each cable with a thermal transfer marker tag indicating the backbone cable link identifier including the following:

a. Strand/pair count and cable type
b. Near end identifier and far end identifier including:

1) Building identifier (b) for inter building cable
2) Telecomm space identifier (fs)
3) Rack identifier (xy)
4) Panel identifier (-r)
5) Port grouping(:p)

2. Label Backbone cables at termination points and entrance/exit point of telecom space.
3. Outside plant pathways: In addition to labels at termination points, label each backbone cable at all manholes, handholes, and pull points where cable enters and exits pathway.

F. Horizontal Cables:
1. Label each cable with a vinyl self-laminating label indicating the horizontal cabling link identifier including:

a. Room and faceplate number.
b. Telecomm Space identifier (fs)
c. Rack identifier (xy)
d. Patch Panel identifier (-r)
e. Patch Panel port number (:p)

2. Outside plant pathways: In addition to labels at termination points, label each cable at manholes, handholes, and pull points where cable enters and exits pathway.

G. Faceplates:

1. Label individual faceplates with self-adhesive labels or manufacturer provide insert. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential

designation, numbered clockwise when entering room from primary egress, indicating the following:

a. Room number of outlet
b. Faceplate number.

2. Label each individual jack within the same faceplate with its horizontal link identifier.

H. Telecommunications Bonding Busbars and Conductors

1. Label each Busbar with a self-adhesive label indicating the following:

a. Telecomm space identifier (fs)
b. Busbar identifier

2. Label each bonding conductor with a vinyl self-laminating label indicating the far end busbar or object identifier
3. Label each bonding conductor at its attachment point with a thermal transfer marker tag with the following.

a. WARNING: IF CABLE OR CONNECTOR IS LOOSE IT MUST BE REMOVED, PLEASE CONTACT TELECOMMUNICATIONS MANAGER.

4. Warning labels: yellow marker plate type with black print.

I. Underground duct and raceway

1. Label both ends of each underground duct and raceway with self-adhesive label indicating the following:
a. Pathway Identifier and sequence number
b. Far End Building Identifier (b)
c. Far End Telecomm Space Identifier (fs)
d. Far End Outdoor Space Identifier (T)

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backboards
2. 19-inch equipment racks.
3. 19-inch freestanding equipment cabinets.
4. 19-inch wall-mounted equipment cabinets.
5. Cable Management.
6. Ladder Rack/Cable Runway.
7. Rack Power Distribution.
8. Rack Bonding Busbars.
9. Building Entrance Protection.

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 271300 "Communications Backbone Cabling" for copper, optical fiber, and coaxial data cabling and termination devices.
3. Section 271500 "Communications Horizontal Cabling" for copper and coaxial data cabling and termination devices.

1.3 REFERENCES

A. Abbreviations

1. RCDD: Registered communications distribution designer.
2. SBB: Secondary Bonding Busbar (Formerly TGB).
3. PBB: Primary Bonding Busbar (Formerly TMGB).
4. RBB: Rack/Cabinet Bonding Busbar.

B. Definitions

1. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
2. Ladder Rack: A specialized cable tray with side stringers and cross members, resembling a ladder, which supports cable either vertically or horizontally within an equipment room.
3. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. Building Industry Consulting Service International (BICSI)

a. ANSI/BICSI N1 “Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure”

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For custom equipment racks and cabinets.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL Listed.

B. RoHS compliant.

2.2 BACKBOARDS

A. Backboards: AC grade plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Backboard Paint: Light-colored fire-retardant paint.

2.3 19-INCH EQUIPMENT RACKS

A. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:

TBD

C. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks:

1. Overall Height: 84 inches or as indicated on Drawings.
2. Overall Depth: 20 inches.
3. Upright Depth: 3 inches.
4. Two-Post Load Rating: 1000 lb minimum.
5. Four-Post Load Rating: 2000 lb minimum.
6. Number of Rack Units per Rack: 45U or as indicated on Drawings.

    a. Numbering: Every rack unit, on interior of rack.

7. Threads: #12-24 universal hole pattern.
8. Provisions for attaching vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
10. Top shall have provisions for attaching to cable tray or ceiling.
11. Self-leveling.
12. Four post rack shall be adjustable in depth in 1” increments.
13. Horizontal RBB for two post racks, Vertical RBB for four post racks.

E. Wall-Mounted Racks:

1. Height: 40” minimum or as indicated on Drawings.
2. Depth: 29 inches minimum.
3. Load Rating: 150 lbs minimum.
4. Number of Rack Units per Rack: 19U minimum or as indicated on Drawings .
5. Threads: #12-24 universal hole pattern.
6. Wall Attachment: Four mounting holes.
7. Equipment Access: Integral swing.
8. Horizontal RBB.

2.4 19-INCH EQUIPMENT CABINETS

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
1. TBD

C. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Modular Freestanding Cabinets:

1. Overall Height: 84 inches or as indicated on Drawings.
2. Overall Depth: minimum 36-inches.
3. Load Rating: 2500 lb minimum.
4. Number of Rack Units: 45 or as indicated on Drawings.

a. Numbering: Every rack unit, on interior of rack.

5. Threads: #12-24 universal hole pattern.
6. Removable and lockable side and top panels.
7. Perforated, hinged, and lockable front and rear doors.
8. Adjustable feet for leveling.
9. Cable ports with sealed grommets in top panel.
10. Integral lashing brackets and vertical cable management.
11. Vertical RBB.
12. Rack-mounted, minimum 550-cfm fan with filter.
13. Power strip.
14. All cabinets keyed alike.
15. Bonding wires for all panels.

E. Modular Wall Mounted Cabinets:

1. Height: 36 inches or as indicated on Drawings.
2. Depth: 30 inch minimum.
3. Load Rating: 200 lb minimum.
4. Number of Rack Units: 18U or as indicated on Drawings.
5. Threads: #12-24 universal hole pattern.
6. Dual Hinged swing out body
7. Lockable front and rear doors.
8. Louvered side panels.
9. Knockouts for conduit or cable entry grommets in top and bottom rear.
10. Integral lashing brackets and vertical cable management.
11. Grounding lugs.
12. Horizontal RBB.
13. Side-mounted, minimum 100-cfm fan.
14. All cabinets keyed alike.
15. Bonding wires for all panels.

2.5 CABLE MANAGEMENT

A. Description: accommodates the support and orderly routing of cabling inside equipment racks and/or cabinets within the communications rooms. Managers shall protect network equipment by controlling cable bend radius and providing cable strain relief.

B. Source Limitations: Obtain rack/cabinet cable management from same manufacturer or alliance partner as the rack/cabinet.

C. Vertical Cable Management for Racks and Cabinets

1. Double sided, front and rear
2. Mounts to side of rack/cabinet
3. Material: Steel panels and Plastic fingers
4. Cable fingers with rounded edges at 1U intervals
5. Height to match rack/cabinet
6. Width: 6” or as indicated on drawings
7. Cable distribution spools
8. Color: Black
9. Hinged front and rear doors

D. Horizontal Cable Management for Racks and Cabinets

1. Double sided, front and rear
2. Cable finger with rounded edges along top and bottom surfaces
3. Hinged front and rear cover
4. Height: 2U or as indicated on drawings
5. Color: Black

E. Cable Support Rings: NTRL labeled. Designed to prevent degradation of cable performance and pinch points that could damage cable.

1. D-shaped wall mount loop designed for cable management
2. Continuous loop for pull through cable installation or open slot insertion type cable installation
3. Size: various pre-manufactured sizes
4. Mounting holes for attachment with screws
5. Material: Rigid nylon or zinc covered steel

2.6 LADDER RACK/CABLE RUNWAY

A. Description: Accommodates the support and orderly routing of cabling within the communications rooms from the cable pathway to the equipment racks and/or cabinets.

B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:

1. TBD

C. General Requirements

1. 1-1/2 inch high by 3/8-inch-wide tubular steel
2. Rung spacing: minimum 12-inches on center.
3. Color: Black powder coat
4. Width: 12-inches or as indicated on Drawings
5. Minimum linear cable bearing surface of 1-1/2 inches per linear foot.

D. Fittings and Accessories:

1. Install all fittings, supports, splices, etc. for the ladder rack system to provide a complete assembly- including fasteners, hardware, and other items required to complete the installation as indicated on the drawings.
2. Fittings shall be pre-manufactured and match rung size and spacing, material, and finish of ladder rack.
3. Mechanically connect ladder rack sections and turns together with splices and jumpers to form an electrically continuous pathway.

2.7 RACK POWER DISTRIBTUTION

A. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:

1. TBD

B. Power Distribution Unit: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Height: 1 RU.
4. Housing: Metal
5. Minimum Two front-facing 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R and Ten rear facing 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
6. LED indicator lights for power and protection status.
7. LED indicator lights for reverse polarity and open outlet ground.
8. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
9. Cord connected with 10-foot line cord.
10. Rocker-type on-off switch, illuminated when in on position.
11. Surge Protection: UL 1449, Type 3.
    a. Maximum Surge Current, Line to Neutral: 96 kA and neutral to ground.
    b. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall not be more than 330 V.
    c. EMI/RFI noise filtering: 40-80dB.
    d. AC Suppression Joule Rating: 3800 J minimum.

2.8 RACK BONDING BUSBAR

A. Comply with requirements in Section 270526 - Grounding and Bonding for Communications Systems for bonding conductors and connectors.

B. Source Limitations: Obtain rack/cabinet grounding hardware from same manufacturer or alliance partner as rack/cabinet.

C. Rack and Cabinet Bonding Busbars (RBB): Rectangular bars of electro-plated copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-C. Predrilling shall be with holes for use with lugs specified in this Section.

1. Rack-Mounted Horizontal RBB: Designed for mounting in 19-inch equipment racks. Include stainless-steel or copper-plated hardware and insulator blocks for attachment to the rack.
2. Rack-Mounted Vertical RBB: 72 inches long, with stainless-steel or copper-plated hardware and insulator blocks for attachment to rack.

D. Stand-Off Brackets: Non-conductive nylon “L” brackets mounted to back channel of rack/cabinet, providing tie-down point for grounding and bonding cable runs.

2.9 BUILDING ENTRANCE PROTECTION

A. Description: The building entrance protection terminals safeguard communication equipment from damaging electrical surges on outside plant cables.

B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:

1. TBD

C. Terminals: Comply with UL497 for primary and secondary protection.

1. Accept UL listed industry standard 5-pin protection modules.
2. Built in splice chamber for input cable
3. 66 block style quick clip connectors for input and output terminals
4. Available in 25, 50, and 100 pair counts
5. Stackable to accommodate future growth
6. Internal 26AWG fuse link.

D. Protection Modules

1. Solid State protector module with self-resetting current limiters.
2. Minimum 5 ns transient surge response time

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 270528 - Pathways for Communications Systems for materials and installation requirements for raceways.

3.2 INSTALLATION

A. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

B. Backboards:

1. Install from 6-inches to 8-feet, 6-inches above finished floor on all walls of communications space with A side exposed to the interior. Ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of fire-retardant paint, leaving fire rating stamp visible.

C. Racks and Cabinets

1. Provide racks and cabinets with a minimum 36-inches of clear, unobstructed space from the front and rear of the rack/cabinet.
2. Securely fasten floor mounted racks and cabinets to the structural floor using manufacturers recommended anchors or as required by local codes.
3. Install wall mounted racks and cabinets with hinged enclosures or frames so that it can be accessed fully without obstruction by other building, storage, or architectural components. Follow the manufacturer's installation instructions for securing the rack/cabinet to the wall and backboard.
4. Install and adjust to position all rack/cabinet accessories including cable management, power distribution, mounting rails, thermal management, and grounding prior to installing any equipment into the rack/cabinet.

D. Cable Management

1. Attach vertical cable managers to the side of the rack/cabinet using the manufacturer’s installation instructions and included hardware.

2. When a single vertical cable manager is used between two racks/frames, attach the vertical cable manager to both racks/frames.
3. Locate horizontal managers so that the number of ports (cables) that each manager supports does not exceed each cable manager's cable fill capacity. Provide a minimum of one horizontal cable manager above each patch panel.
4. The color of the rack(s)/cabinets(s) and cable manager(s) must match.
5. Securely attach covers to the cable manager(s) after cabling is complete.
6. Space rings at maximum intervals of 12 inches along the path of the cables served.
7. Provide rings of sufficient size and quantity so that no ring is utilizing more than 25% of the rated capacity.

3.3 LADDER RACK/CABLE RUNWAY

A. Secure to the structural ceiling, building truss system, wall, or floor and to the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware.

B. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.

C. Support ladder rack in accordance with TIA-569-E and the following:
1. A minimum of every 5-feet for straight runs.
2. Within 2-feet of every splice.
3. Within 2-feet on all sides of every intersection.
4. Within 2-feet on both sides of every change in elevation.
5. Every 2-feet when attached vertically to a wall.

D. Leave a minimum of 12-inches in between ladder rack and ceiling/building truss structure. Install multiple tiers of ladder rack with a minimum clearance of 12-inches in between each tier of ladder rack.

E. Provide an elevation kit to maintain a minimum of 6-inches in between ladder rack and the tops of equipment racks and/or cabinets.

F. Provide vertical ladder rack and supports where vertical distance between sleeves/pathways and horizontal ladder rack exceeds 5-feet.

G. Within each telecommunications room, bond ladder rack together with manufacturer's recommended ground straps, and bond to the PBB/SBB, unless otherwise noted in the specifications and contract documents.
1. Bond ladder rack and turns across each splice with a bonding kit.
2. Bond ladder rack to the PBB/SBB using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ.
3. Remove paint from the ladder rack where bonding/ground lugs contact the ladder rack so that the lug will contact bare metal.
4. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug and in between the bus bar and the ground lug.
5. Verify continuity through the bonds at splices, intersections between individual ladder rack sections and turns, and through the bond to the PBB/SBB.

H. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, cabinet, or termination field. Provide a moveable cross member to attach and align the radius drop in between the welded cross members of a ladder rack.

I. Cover the exposed ends of the ladder rack that do not terminate against a wall, the floor, or the ceiling with end caps made from a rubberized material or an end closing kit.

J. Provide touch-up paint color-matched to the finish on the ladder rack and correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner.

K. Initial cable fill shall not exceed 2-inches in height and shall not exceed 25% of the interior area of the ladder rack. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2-inches. Provide cable retaining posts where initial cable fill is exceeded.

L. Do not exceed load ratings specified by manufacturer.

3.4 GROUNDING

A. Provide bonding conductors and connectors in accordance with requirements in Section 270526 - Grounding and Bonding for Communications Systems.

B. Clean the rack bonding busbar (RBB) and apply a compatible anti-oxidant prior to fastening connectors to the busbar.

C. Install RBB on rack or cabinet using block insulators to provide a minimum of 0.75 inches of separation.

D. Connect RBB to either the Rack Bonding Conductor (RBC) or Telecommunications Equipment Bonding Conductor (TEBC) and to the rack using listed compression two-hole lugs.

3.5 IDENTIFICATION

A. Provide component labelling in accordance with requirements in Section 270553 - Identification for Electrical Systems.

END OF SECTION 271100

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 260000 “General Requirements for Electrical”, apply to this Section.

1.2 SUMMARY

A. Horizontal Cabling Description

1. Horizontal cable and its connecting hardware provide means of transporting signals between a telecommunications outlet/connector and the horizontal cross connect located in a telecommunications room. The cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection. This cabling and its connecting hardware are called a “permanent link,” a term that is used in the testing protocols.
2. A work area is approximately 100 sq. ft. , and includes the components that extend from the equipment outlets to the station equipment.
3. The maximum allowable horizontal cable length is 295 feet . This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

B. Section Includes:

1. Twisted Pair Cabling
2. Twisted pair cable connecting hardware, including patch panels and cross connects
3. Telecommunications outlets/connectors, including plugs and jacks.
4. Grounding provisions for twisted pair cable.
5. Source quality control requirements for twisted pair cable.

1.3 REFERENCES

A. Abbreviations

1. EMI: Electromagnetic Interference
2. IDC: Insulation Displacement Contact
3. UTP: Unshielded Twisted Pair

B. Definitions

1. Horizontal Cabling: Distribution media that connects the telecommunications outlet/connector at the work area and the horizontal cross-connect in the telecommunications room or enclosure.

2. Telecommunications Outlet: An assembly consisting of a faceplate, backbox, or supporting bracket, and one or more receptacles or jacks of a telecommunication connector. Also known as a work area outlet.

C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. Building Industry Consulting Service International (BICSI)

a. ANSI/BICSI N1, “Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure”

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Twisted Pair and Coaxial Cable Testing Plans:
1. Sample test report sheet for each type of test required
2. Description of the cable testing procedures to be used including equipment to be used and testing standards equipment will test to.

C. Closeout Submittal
1. Operation and Maintenance Data: In addition to the items specified in Division 01 and Section 260000 “General Requirements for Electrical” include the following:
a. Cable Test Results

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with minimum performance values listed herein and transmission standards in TIA-568.1, when tested according to test procedures of this standard.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard, UL 444, and NFPA 70 for the following types:

1. Plenum Applications: Type CMP complying with NFPA 262.
2. Non-plenum applications: Type CMR complying with UL 1666.
3. Wet Location and Outdoor Applications: OSP.

B. 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: 50 or less.

C. RoHS compliant.

2.3 STANDARDS COMPLIANT CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:

1. TBD

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP) unless noted otherwise.

F. Jacket: Blue thermoplastic unless noted otherwise.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of the twisted pair cabling.
2. Comply with TIA-568.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer or alliance partner as twisted pair cable.

D. Expansion Criteria: Unless otherwise noted, provide spare positions in cross connects and patch panels to accommodate 20% future growth.

E. Connecting Blocks:

1. 110-style IDC
2. 50, 100, and 300 pair footprint.
3. Supports termination of 22-24 AWG solid conductors.
4. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between horizontal and backbone cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Management rings shall be provided between vertical columns of blocks to provide management of cross connect wire.

G. Modular Patch Panel: Metal patch panel with numbered jack units that accept modular type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:
    a. Universal T568A and T568B wiring labels.
    b. Labeling areas adjacent to conductors.
    c. Replaceable connectors.
    d. 24 or 48 ports.
    e. Strain Relief Bar
2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

H. Patch Cords: Factory-made, four-pair cables in various lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.
3. Patch cords shall match performance rating of horizontal link.

I. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable, rated to match performance of horizontal link.
2. Standard: Comply with TIA-568.2.
3. Marked to indicate transmission performance.

J. Modular Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable, rated to match performance of horizontal link.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568.2.
4. Marked to indicate transmission performance.

K. Faceplate:

1. Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color
3. Metal Faceplate: Stainless steel, complying with requirements
4. For use with snap-in modular jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

L. Surface Mount Box

1. Two port, low profile, surface mount housing, with removeable cover.
2. Plastic housing suitable for installation in plenum air handling spaces. Coordinate color.
3. For use with snap-in modular jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, 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 270528 "Pathways for Communications Systems."
3. Unenclosed wiring methods may be used in accessible ceiling spaces.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. General Requirements for Cabling:

1. Provide a minimum of two equipment jacks for each work area outlet unless noted otherwise.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Maintain the cable jacket to within 1-inch of the termination point.
6. Provide horizontal cabling with the following minimum bending radius:
    a. Twisted Pair Cable: 4 times the outside diameter of the cable.
    b. Coax Cable: 10 times the outside diameter of the cable.
7. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
8. Use T568B standard for terminations.
9. Coil cables in the outlet boxes if adequate space is present to house the cable coil without exceeding the cable bend radius.
10. Store no more than 12-inches of twisted pair and 36-inches of fiber optic cable in an outlet box or modular furniture raceway after termination. Loosely store excess slack in the ceiling above each drop location.
11. In the telecommunications room, provide minimum 10-foot of slack for all horizontal cables and dress/store on ladder rack system without exceeding the cable bend radius.
12. Store cable slack in a Figure 8, “U” or “S” pattern.
13. MUTOAs shall not be used as a cross-connect point.
14. Provide consolidation point and cabling listed for wet locations at floor boxes in slab-on grade construction.:
    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.

15. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
16. Provide blank filler inserts for all unused work area faceplate ports.
17. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
18. Cables shall be neatly bundled and dressed into groups of no more than 48 cables and routed from the point of entrance into the telecommunications space to their respective patch panel or connecting block.
19. Each patch panel or connecting block shall be fed by individual bundles separated and dressed with hook and loop straps.
20. Install lacing bars and distribution spools to restrain cables, prevent straining connections, and maintain minimum bending radii.
21. 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.
22. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
23. Pulling Cable: Comply with BICSI Information Technology Systems Installation Methods Manual (ITSIMM), "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
24. Under no circumstances shall the cable or patch cords be painted, treated, or covered with other material unless approved by the manufacturer, Owner, and Engineer.

B. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable management in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members, attached to ceiling grid/luminaire supports, or in contact with pipes, ducts, or other potentially damaging items.
3. Cable and support hardware shall not obstruct access to panels, equipment, valves, boxes, or other control devices.

C. Group connecting hardware for cables into separate logical fields.

D. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 IDENTIFICATION

A. Provide identification of cabling and devices in accordance with Section 270533 “Identification for Communications Systems”.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections on all new and modified cabling and termination hardware.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually confirm Category marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Field-test instruments shall be approved by the cable manufacturer, be within the calibration period recommended by the instrument manufacturer, and meet a minimum Level IV accuracy in accordance with TIA-1152. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. Twisted Pair Continuity Tests:

    a. Test twisted pair cabling for shorts, opens, intermittent faults, polarity and pair reversals, crossed pairs, and split pairs. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

6. Twisted Pair Performance Tests:

    a. Test each cable link to the performance requirements outlined in this specification and manufacturer’s warranty requirements. Perform the following tests according to TIA-568.1, TIA-568.2, and TIA-1152:

        1) Wire Map
        2) Length (physical vs. electrical, and length requirements).
        3) DC resistance.
        4) DC resistance unbalance.
        5) Insertion loss.
        6) Near-end crosstalk (NEXT) loss.

7) Power sum near-end crosstalk (PSNEXT) loss.
8) Equal-level far-end crosstalk (ELFEXT).
9) Power sum equal-level far-end crosstalk (PSELFEXT).
10) Return loss.
11) Propagation delay.
12) Delay skew.

7. Final Verification Tests: Perform verification tests for UTP systems after the complete communication cabling and workstation outlet/connectors are installed.

   a. Voice Tests: After dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
   b. Data Tests: After Owner's Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, printed, and submitted unaltered.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections. Marginal passes are not acceptable.

E. Remove, replace, and re-test cabling and terminations where test results indicate that they do not comply with specified requirements.

F. Prepare test and inspection reports.

G. The Engineer may request that a 10% random field re-test be conducted on the cabling system, at no additional cost, to verify documented findings. Tests shall conform to the requirements listed above. If findings contradict the documentation submitted by the contractor, additional testing can be requested to the extent deemed necessary by the Engineer, including a 100% re-test. Any re-testing shall be at no additional cost to the Owner.

END OF SECTION 271500

SECTION 281643 - PERIMETER SECURITY SAFETY

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Security Management System (SMS) for the project.

B. Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. SMS shall consist of but not be limited to Door Controllers, Card Readers, Sensors, Switches, Conduit, Boxes, Cable and Wired Devices. Programming and cardholder enrolling are also considered as part of installation as well as coordination with UKPD.

C. Unless noted otherwise, "Contractor" shall refer to SMS Integrator & Installer.

Communications routing from SMS to door controllers shall be via Owner LAN.

1.2 RELATED WORK

A. Related Sections in other divisions of Work:

087100 – DOOR HARDWARE
260000 - ELECTRIC
270000 - COMMUNICATIONS

1.3 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Division 1 General Requirements.

B. Other applicable standards are as follows:

UL 294 - Access Control System Units.
UL 1076 - Proprietary Burglar Alarm Units and Systems.
FCC Rules and Regulations Part 15, Radio Frequency Devices

C. All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code.

D. All materials shall be listed by UL and shall bear UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply, and such items shall bear those labels. Where UL has, an applicable system listing, and label entire system shall be so labeled.

1.4 DEFINITIONS AND ABBREVIATIONS

A. SMS – Security Management System

1.5 WORK BY OWNER

A. Owner shall:

Provide list of cardholders for initial SMS programming by Contractor.
Provide scheduling of each door, including:

a. Alarm activations and distribution.
b. Door lock and unlock.
c. Cardholder validation by day and time.

d. Delay time of door open alarm.
e. Duration of lock activation upon credential authorization.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. System Design drawings with cable routing, device location and labeling.

C. Operation statements for all SMS doors.

D. Communication Closet layout drawings.

E. Certifications for BICSI as required by UKCNS per Division 27.

F. Owner Operation Manuals for all installed equipment as well as documentation of all programing.

G. As built drawings showing cable pathways and routing. As built drawings to also show any changes made to original ESS drawings.

1.7 QUALITY ASSURANCE

A. Security Management System Contractor shall:

Have successfully completed two (2) Security Systems projects in equal magnitude of the system specified in following sections. Contractor shall be a Lenel Authorized VAR in good standing. Proper proof of certifications will be submitted at time of Bid. Be responsible for complete turnkey system up to but not including SMS programing, programing cost will be included in BID with Programing work being done by UKPD's Lenel VAR of Record. Be responsible to coordinate with UKPD's Lenel VAR of Record to complete system installation. Comply with all certification requirements set out in Division 27 as it related to the installation of DATA cabling. Specifically, contractor will comply with the requirement of all DATA cabling being installed by BICSI certified installers and installation supervised by a registered in good standing RCDD in the full-time employee of the project contractor.

1.8 GUARANTEE

A. Warranty requirements for Security Management System (SMS) shall be two (2) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Security Management System shall provide ability to:

Unlock electrified door locks upon authentication of submitted credential to local card readers.
Monitor door alarms and remotely unlock.
Lock doors on an automated schedule from central system.
Unlock doors as required by code via fire alarm relays.
Annunciate intrusion alarms from remote sensors.
Unlock individual doors manually via operator interface.
Lock doors from central Operations Center.

B. System must support the Campus Central One Card ID Badge.

2.2 NETWORK SMS

A. Manufacturer: Lenel Security Systems

2.3 SYSTEM CONTROLLER

A. Manufacturer: Mercury Systems LNL-2220. Controllers will include all power supplies, Life Safety FPO250 or Mercury Systems approved equal and Battery Back Up Units. All parts and pieces needed for a complete UL listed working turnkey system. All Lenel Licensing required for UK Campus Enterprise System shall be included Contractors Bid.

2.4 MULTI-DOOR DOOR CONTROLLER

A. Manufacturer: Mercury Systems LNL-1320.

Controller shall accommodate minimum two card readers and associated inputs/outputs.

2.5 MULTI-INPUT / OUTPUT CONTROLLER

A. Manufacturer: Mercury Systems LNL-1100 / LNL-1200.

Controller shall accommodate 16 programmable inputs: 2 programmable relay outputs.

2.6 PROXIMITY CARD READERS

A. Manufacturer: HID

Mullion Mount: 20TKS-T0-000375 (SIGNO PRIORITY LINE)

Standard
Wall-mount: 40TKS-T0-000375 (SIGNO PRIORITY LINE)

B. General

Reader(s) shall:

a. Be furnished in Wiegand, and OSDP, output model and shall be sealed in a polycarbonate enclosure designed to withstand harsh environments.
b. Unless otherwise specified, reader covers shall be furnished in “black” color – Classic design.
c. Recognize iClass 13.56 MHz signals.
d. Contain an indicator to indicate valid and invalid card.
e. Be designed for ambient operating environment.
f. Be powered remotely using centralized power supplies.
g. Read iClass Corporate 1000 sector information.
h. Include Near Field / Bluetooth capabilities.

2.7 BIOMETRIC READERS (Eye Scanners)

Manufacturer: EyeLock

Wall-mount Model: nano iXT

Scanner(s) shall:

a. Be mounted at 54” AFF typically.
b. Be mounted above card reader.
c. Always be installed in conjunction with a Card Reader
d. Be installed with DATA cable connected to POE Network Switch port.
e. Be installed with 12-24 Volt DC Power via hard wire cable to dedicated Life Safety Power Supply located in nearest UKCNS Data Closet. Each Scanner Unit shall be fused at the power supply individually.

2.8 DOOR CONTACTS (DPS / Monitor Points when not included in Door Hardware)

Steel Door contacts.

Manufacturers: GE Interlogix 1078 Series or approved equal.

2.9 REQUEST-TO-EXIT MOTIONS SENSORS (When not included in Door Hardware)

Manufacturers: GE, Honeywell, or approved equivalent.

1. Provide door header mounted request to exit motion sensors as indicated on Drawings.

2. Minimum Specifications

a. Detection technology Passive infrared
b. Detection pattern Narrow beam 35-degree cone
c. Output contact normally open contact is closed when sensing zone is entered or exited.
d. Power requirements 12 – 24 VDC
e. Mounting: Door header

2.10 Panic Button

Under Counter Model:

Manufacturer: Honeywell 270R
Panic button is hard cabled to the nearest access control panel for reporting to UKPD dispatch. Coordinate with UKPD for final placement and programing.

Classroom / Lab Model: (Wall Mounted)

Manufacturer: STI Stopper Station SS2 with Cover
Model: SS2325LD-EN
Coordinate colors and labeling with UKPD

2.11 POWER SUPPLIES

A. As required to support Card Reader(s), Door Controller(s), Strike(s), Sensor(s), Eye Scanners and other components for fully operational turnkey system. Each component connected to power supplies shall be independently fused with rated fuses to match the manufacturer requirements for each specific device. Power supply cabinets shall have door locks included and keys shall be turned over to UKPD at substantial completion.

B. Electrified Door hardware power supplies shall be specified by Division 8. Each component connected to power supplies shall be independently fused with rated fuses to match the manufacturer requirements for each specific device.

2.12 CABLING

A. General

Cable shall be:

a. Plenum Rated.

B. Reader Cable

Construction:

a. 18 AWG stranded or as recommended by system manufacturer.
b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

C. Door Lock Power Cable

Provide and install as required for door hardware. Refer to Architectural Door Schedule and Door Hardware documents.

D. Door Contact / Signal Cable

Door Contact/Signal Cable used for monitoring purposes.
Construction:

a. 22 AWG twisted, stranded, or as recommended by system manufacturer.
b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

E. Request-to-Exit Motion Detector Signal Cable

Motion Detector Signal Cable used for monitoring purposes.
Construction:

a. 20 AWG stranded or as recommended by system manufacturer.
b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

F. Door Controller Cable

Provide all LAN patch cables, jacks, and faceplates

PART 3 - EXECUTION

3.1 PRE-INSTALLATION COORDINATION

A. Coordinate with Electrical Contractor (Division 260000) that:

Section 280000 provided pathways and equipment back boxes are completed and are coordinated with no conflicts for system installation.
Adequate power has been provided and properly located for security system equipment.
Code-complying fire alarm relays will be installed for cable termination. Fire Alarm contractor will provide relay contacts in Com Closet for connection to Access control panels. Contractor is responsible for coordination with Fire Alarm Contractor. Access control Contractor shall provide all parts and pieces including all cabling from Access control panel to Fire Alarm Contact point.
Coordinate scheduling of work to make sure there are no conflicts.

B. Coordinate with Door Frame supplier (Division 8):

Doors and door frames are properly prepared for electric locking hardware and door position switches are furnished by door type.
Locations of all devices prior to installation.
Electric door power supply locations and connections requirements.

C. Coordinate with the Communications Contractor (Division 27):

Locations of all LAN-connected devices with no conflicts.
Coordinate scheduling of work.

D. At a minimum, coordinate the following with Owner:

VLAN/or network partitioning for SMS system.
Owner-provided IP addresses for SMS devices.
Network infrastructure requirements at SMS head-end Next Level Gateway-6100UK.
Initial database programming.
Planned system downtime.
Programming and training for new system.

E. Coordinate with Construction Manager as required providing a fully functioning turnkey Security system.

F. Coordinate with all trades on the operation and installation of ADA entrance doors with relation to Long Range Card Readers and interconnection with door actuator plates, motor units, Fire Alarm and Smoke Evacuation System. Contractor will supply all associated timer boards or additional parts required for complete operating doors system.

G. Coordination Meetings shall be scheduled and conducted beginning within 60 days of contract award and continuing till project conclusion inclusive with the A/E team and Commissioning Agent.

3.2 INSTALLATION

A. General

Verify acceptance of each type of specified request-to-exit hardware for each application with local life safety code officials.
Provide tamper proof fasteners for all equipment in public areas. Fastener finish shall match equipment finish.
Maintain minimum three feet of access in front of class 1 electrical equipment.

B. Delivery, Storage, and Handling

Deliver products to and receive products at site under provisions of General Requirements.
Materials shall be stored according to manufacturer's recommendations at minimum.

C. Equipment

Provide equipment as indicated on Drawings and specified herein. Additional specific installation requirements are as follows:

Door Controllers

a. Provide Door Controllers in Data Closets as shown on Drawings.
b. Provide connection to 120 VAC via hardwire conduit. Coordination with Division 260000.
c. Separate 24 VDC and 120 VAC, wire, cable, and devices by 12” minimum space.
d. Enclose wire and cable in wire ways or bundle with wire exiting wire ways to terminal strips or panel mounted devices.
e. Space controllers according to manufacturer’s requirements. Ensure adequate space is allowed for device heat dissipation.
f. Do not place controller or control devices on enclosure sides.

Card Readers

g. Provide card readers and card reader devices as shown on Drawings.
h. Wire card reader LEDs to indicate valid and invalid card reads, and door locked and unlocked conditions. All card reader LED indicators shall operate identically throughout Project. LED shall be red in normal, secured state, and shall be green on valid card read and while door is unlocked.

Electric Locking Mechanics

i. Interface with electric locking mechanics as required by the door hardware.
j. Provide lock control of electrified locking mechanics through output contacts activated by Door Controller.

Electrified Panic Devices

k. Interface with electrified panic devices as indicated on Drawings. Provide all low-voltage wire and connections between SMS power transfer device and electric locking mechanics.
l. Provide lock control of electrified panic devices through output contacts activated by Door Controller.
m. Provide all 120VAC if required for Device operation per hardware specifications. Provide connection to Fire Alarm connection points as required by Code. Fire Alarm Contractor to provide relay contacts in Com closets for this purpose. Contractor is responsible for all parts and pieces including cable from Access control panel to the Fire Alarm relay contract. Contractor is responsible for coordination with Fire Alarm contractor.

Door Position Switches

n. Install as shown on drawings.
o. Coordinate pathways.

Request-to-Exit Motion Sensors

p. Provide as shown on drawings.
q. Coordinate pathways.

Fire Alarm Interface

r. Connect (hard wire) door controller to building fire alarm system for fail-safe release upon any fire alarm.
s. Interface with low voltage / low current normally closed dry contact from fire alarm system provided by fire alarm Contractor (verify exact location in Data Closet for connection with FA). Contact shall open on any fire alarm condition.
t. Provide all additional UL listed fail-safe relays and power supplies necessary to interface to this contact and unlock all fail-secure doors.

u. Coordination Meetings with Fire Alarm Contractor shall be scheduled and conducted beginning within 60 days of contract award and continuing till project conclusion inclusive with the A/E team and Commissioning Agent.

Cable Installation

v. Visually inspect all wire and cable for faulty insulation prior to installation.
w. Furnish and install all specified wire and cable as required for functioning SMS system.
x. Neatly lace, dress and support cabling.
y. Pull cables in accordance with cable manufacturer's recommendations University of Kentucky CNS and ANSI/EEE C2 Standards.

1) Do not exceed manufacturer's recommended pulling tensions.
2) Do not install bruised, kinked, scored, deformed, or abraded cable.
3) Do not splice cable between indicated termination, tap, or junction points.
4) Remove and discard cable where damaged during installation and replace it with new cable.
5) Pull all cable by hand unless installation conditions require mechanical assistance.

z. Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.
aa. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports, or electrical or communications conduit.
bb. Cable shall never be laid directly on a ceiling grid or attached in any manner to ceiling grid wires.
cc. Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications at install locations.

1) Loosely coil slack in “Figure-eight” in a manner that prevents kinking.
2) Loop radius shall be at least 4X minimum bend radius for cable.
3) Slack length of cable shall be 4 feet (minimum).

dd. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS System.
ee. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with General Contractor.
ff. At no time, shall any cable be subjected to a bend less than manufacturer’s specified minimum radius and UK CNS Standards.
gg. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.
hh. Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers’ recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.
ii. Utilize conduit and cable trays and or pathways to route SMS cables from each door or device to Door Controller. Follow University of Kentucky CNS standards for low voltage cabling.
jj. No A/C current-carrying conductors are allowed in same pathway as signal or low-voltage power cables.
kk. Wire and cable within Door Controllers, enclosures and or other security enclosures shall be neatly installed, completely terminated, pulled tight with slack removed and routed in such a way as to allow direct, unimpeded access to equipment within

enclosure. All wire and cable shall be bundled and tied. Ties shall be similar to T&B TyRap cable ties.

ll. Use of electrical tape for splices and connections shall not be acceptable.

mm. Make connections with solder less devices, mechanically and electrically secured in accordance with manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

nn. All system cabling within vertical risers (as required) shall be bundled, wrapped and tied to structure at three-meter intervals in order to isolate it from other wire and cable within riser. Additionally, all wire and cable within shaft shall be supported at least every two floors using Greenlee Slack Grips (Split Mesh Lace Closing) or approved equal. Provide all personnel and equipment necessary to install and support cable. All equipment shall be UL listed for application.

D. System Programming and Data Entry

Collect all data required to make the Security Management System operational. Deliver data to Owner on data entry forms, utilizing data from Contract Documents, Contractor's field surveys and all or pertinent information in Contractor's possession required for complete installation database. Identify and request from Owner any additional data needed to make SMS System fully operational and integrated. Completed forms shall be delivered to Owner for review and approval at least 30 days prior to Contractor's scheduled needed date. Contractor will coordinate with University of Kentucky Police Department Campus Security System Lenel VAR of Record (Securitas) for database and Campus Cloud Services programming and Integration. Contractor shall provide Door Counts, Panel Counts and locations, Reader Counts and input, output counts. Contractor shall also supply any special devices or operations that may require special programing. Examples would be Elevators, Biometric readers, and others. Contractor shall request a quote for this programing work, two (2) Client Workstation Licenses and any other Lenel Licenses required from Securitas. Securitas Security Group Contact person is Vicky Daugherty (912-246-9466) Vicky.Daugherty@securitas.com. This and any fees associated with the Lenel programing shall be included in Contractor's Bid. Contractors Bid shall be for a complete turnkey total functional system. Contractor shall provide time in Bid to coordinate and participate with Securitas Security during their testing and programing.

Provide all initial system information for SMS setup including, but not limited to following:

a. SMS Card Reader Information

1) Coordinate all card reader values and text, including descriptors, alarm messages, map call up and identification with Owner.

b. Input and output points for SMS. Coordinate all input and output priorities and text, including descriptors, alarm messages, Video Camera call up, and map call up and identification with Engineer.

c. Initial system users, including levels of access. This shall include designation of Owner's representative at "Super User" level immediately upon SMS initialization.

d. Provide Elevator access per cardholder by cab and floor.

E. Furnish and install all SMS wire and cable including LAN cabling.

F. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS.

G. 120 VAC power dedicated to security system shall be on provided Emergency Generator Power. Gateways shall be on properly sized UPS units on Emergency Generator backup circuits. UPS units are provided by UKCNS. Contractor shall coordinate with UKCNS to provide power requirements for all equipment. A meeting with UKCNS to coordinate this and other IT related issues will be scheduled within 60 days of Contract award and be inclusive of A / E Team, UKCNS and Commissioning Agent.

H. Connect to AC power with provided UL listed power supplies and transformers to distribute low voltage power to system components as required.

I. Provide hinged cover UL listed terminal cabinets with tamper switches for all power supplies, transformers, and power distribution terminal strips. Provide all conduit and wiring from AC power facilities to terminal cabinets.

J. Provide protection against spikes, surges, noise, and or line problems for all system equipment and components.

K. Provide protection on all exterior, control, power, signal cables and conductors against power surges. Each surge protector shall be UL Listed.

L. In no instance, shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.

M. Contractor shall be responsible for replacing any labeled door or frame that is modified without written approval from project Engineer.

N. Label all controls as necessary to agree with their function.

O. Label all Wire and Cable in common at both ends using a permanent method such as self-laminating cable marking tape.

Tags shall be attached to wire and cable nylon cable ties in an accessible location so that they can easily be read.

Tags shall be installed when wire and cables are installed.

Labeling shall be consistent with existing cable labeling system and agree with Record Documentation.

P. Place wire identification numbers at each end of conductor involved by using sleeve type, heat shrinkable markers. Markers shall be installed so as to be readable from left to right or top to bottom.

Q. Mark all connectors with common designations for mating connectors. Connector designations shall be indicated on record drawings.

R. Coil all spare conductors in device back box, panel wire way, or top of panel where wire way is not provided. Conductors shall be neatly bundled and tagged.

S. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.

T. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.3 DEMONSTRATION AND TRAINING

A. Coordinate with Owner and UKPD to establish required training.

B. Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been used.

C. Demonstration:

Demonstrate that integrated security and communication system functions properly. Perform demonstration at final system inspection by qualified representative of manufacturer working with UK Lenel VAR of Record.

3.4 SYSTEM START-UP

A. Start-up includes all Contractor-Furnished, Contractor-Installed (CFCI) systems and equipment.

B. Work shall be complete and ready to operate prior to final acceptance.

C. All database programming for systems up to inaugural day of beneficial use of Security System shall be coordinated thru UKPD and UK Lenel VAR of Record.

D. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 SYSTEM ACCEPTANCE

A. Final acceptance testing of Work will be coordinated and observed by owner representatives and UKPD in coordination with Securitas Security Solutions.

B. Prior to testing, Contractor shall submit two sets of preliminary (draft) Record Drawings to owner and UKPD. Preliminary Record Drawings are to be used by owner and UKPD to conduct system final test.

C. At completion of Work, remove all waste materials, rubbish, Contractor's and subcontractors' tools, construction equipment, machinery, and all surplus materials.

3.6 PROTECTION

A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION 281643

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SCOPE

This section details product and execution requirements for VIDEO MANAGEMENT SYSTEM for the project.

Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. VMS shall consist of but not be limited to, Cameras, Monitors, Conduit, Boxes, Cable, and Wired Devices. Programming work sheets and camera view setup is considered part of installation as well as coordination with UKPD, Stanley Security and Salient Systems.

Unless noted otherwise, "Contractor" shall refer to VMS Integrator & Installer.

Communications routing from VMS Servers to Cameras shall be via Owner LAN.

Coordinate with any and all trade contractors as required to provide a fully functioning system.

Unless noted otherwise, "Contractor" shall refer to security system integrator & installer.

Applicable provisions of Division 1 shall govern all work under this section.

Video surveillance can be restricted or prohibited by law. This document details technical considerations only. It is assumed that registration, licensing, policies regarding disclosure and privacy (notification, processing of images, time, and date stamping, recording of sound, etc.), and or legal obligations are responsibility of Owner.

1.2 RELATED WORK

Related Division 28 Sections include:

1. 281643 - PERIMETER SECURITY SAFETY

Related Sections in other divisions of Work:

2. 087100 - DOOR HARDWARE
3. 260000 - ELECTRIC
4. 270000 - COMMUNICATIONS

1.3 REFERENCES AND STANDARDS

Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code, University of Kentucky Standards and University of Kentucky ITS Standards.

All materials shall be listed by UL and shall bear UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply, and such items shall bear those labels. Where UL has an applicable system listing and label entire system shall be so labeled.

Other applicable standards are as follows:

1. ANSI/IEEE C2 - National Electrical Safety Code
2. NFPA 70-1999 - National Electrical Code
3. IEEE/ANSI 142-1982 – Recommendations for Grounding of Industrial & Commercial Power Systems.

4. NTSC/EIA RS-170A Video Standard
5. IEEE 802.3 standards for CSMA/CD (Ethernet) based LANs.
6. Emissions: FCC 15, Class A; CE: EN55022 (Emissions)
7. CE: EN50082-01 (Immunity)
8. CE, UL 1950; CUL 1950 CE: EN60950 (Safety)
9. State of Kentucky
10. City of Lexington, KY

1.4 DEFINITIONS AND ABBREVIATIONS

VMS – Video Management System

LAN – Local Area Network

1.5 WORK BY OWNER

Owner shall provide:

1. Verify exact security device mounting locations.
2. Verify Acceptable per-camera field-of-view information.
3. Enterprise-wide Data Network / LAN to be utilized by VMS system.
4. Cross-connections from VMS components to building LAN, contractor provides all interconnection cables (Patch Cables) as needed but may not connect to LAN without ITS oversight and approval.
5. All active LAN components (switches, routers) as required for Security system function.
6. IP-address allotment and management for VMS devices as needed.

1.6 SUBMITTALS

Product Data: For each type of product indicated.

System Design drawings with cable routing, device location and labeling.

Communication and Security Closet layouts.

Camera View Modeling.

1.7 QUALITY ASSURANCE

Video Management System Contractor shall:

1. Have successfully completed two (2) Salient Systems projects in equal magnitude of the system specified in following sections. Be fully certified by Salient Systems for Sales and Installation of Salient equipment. Proper proof of certification with Salient will be submitted at time of Bid.

1.8 GUARANTEE

Warranty requirements for Video Management System (VMS) shall be two (2) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

VMS system shall deliver high quality; color video over an IP, UTP structured cable system using H.264 /H.265 compression and shall provide for monitoring and recording of all cameras in system as indicated herein and on project Drawings. The VMS allows event-based monitoring of campus and situational awareness though IP cameras centrally managed from the University of Kentucky Police Department Operations Center. The VMS utilizes analytics to identify potential situations on campus and preserving evidence for authorities to review. The Salient VMS has the capability to be securely monitored via mobile devices or off-campus locations, video sharing with outside public safety first responders.

Video shall be configurable from a workstation on the University LAN using standard Browser software.

2.2 IP VIDEO CAMERA (FIXED)

Interior Camera shall be Hanwha XND-L6080V.

Elevator Camera shall be Axis M3057-PLVE

Exterior Camera shall be Hanwha XNV-L6080R

Multi Imager Camera shall be Hanwha PNM-9002VQ

Dual Imager Camera shall be Hanwha PNM-7002VD

Camera shall:

1. Be ceiling / wall mountable dome-type.
2. Be IP-native.
3. Utilize Power-over-Ethernet (PoE) for device power.
4. Be designed to provide video streams at the minimum HDTV 1080p (1920x1080) resolution at 30 frames per second using H. 264 / H.265.
5. Be equipped with Day/Night functionality, Wide Dynamic Range (WDR), color video to ½ lux, black and white below ½ lux and feature remote back focus capabilities.
6. Be provided complete with standard interior (3-9 mm nominal) auto-iris lens.
7. Per-camera lens selection dependent upon Owner-required field-of-view.
8. Have a smoked bubble.
9. Have housing and mount color to match surrounding architectural colors.

2.3 NETWORK VIDEO SERVER:

Security Cameras shall be connected to the owners Security LAN by UKCNS personnel and SMS VAR of Record, Stanley Security. Cameras shall be routed to Management Servers and Recording Servers via the Owners Security VAN. Installing Integrator shall complete all Camera Programing worksheets and provide to Stanley Security for System Programing and addition of Cameras to the Campus VMS. Integrator shall coordinate with VAR of Record, Stanley Security to include the cost of this programing in their bid for project. Contact Stanley Security. Stanley Security Group Contact person is Vicky Daugherty (912-246-9466) Vicky.Daugherty@sbdinc.com.

2.4 WIRE AND CABLE

General

1. Provide and install all device DATA cables as per UKITS and Division 270000 requirements. DATA cabling for Security cameras shall be terminated in each DATA

Closet, in approved labeled patch panels (As per Division 270000 requirements). Camera cabling should be terminated in jacks at the camera device. Contractor to provide all patch cables. All exterior camera cables shall be provided with Surge protection units on each cable. Proper cable types must be must as per UKITS standards and Division 270000 requirements.

2. Provide all interconnecting system cabling at Security Closets and Communication Closets as well at security device end points. All UKITS standards must be followed. Exterior cameras that exceed the normal distance for copper cable must be installed with Fiber Cable as per UKITS Standards and Division 270000 requirements. At these fiber locations a Rugged / Hardened Switch is required, this switch should be provided by contractor by purchase thru UKITS.
3. Bond metallic system components in all Communications Closets and Security Closets to existing in-room ground bar.
4. Confirm and provide any necessary interface cabling with existing Access Control system.

PART 3 - EXECUTION

3.1 GENERAL

Work performed for installation of VMS system shall be performed by Security System Integrator – “Contractor”.

Provide equipment as indicated on Drawings and specified herein.

Provide all labor and materials necessary to construct systems as described herein to include furnishing and installing all system equipment, interconnecting cabling, programming and start-up, software (including software upgrades and reprogramming as necessary), termination components, mounting hardware, incidentals, accessories, testing, labeling, documentation, and training as detailed in following sections.

1. Neatly lace, dress, and support cabling.
2. Coordinate any downtime with Owner.

Prior to installation:

3. Conduit and equipment back boxes are as required. Contractor is responsible for coordination with all trades to ensure that conduit and back boxes are correctly placed for VMS use. Contractor is responsible for coordinating installation of conduit and boxes to make sure they are installed on schedule with other trades and are coordinated as to not interfere with other systems or pathways.
4. 120V AC Power is as required and is properly located.
5. LAN structured cabling is as required and properly located, and installation has been coordinated with other trades.
6. Coordinate all devices and locations prior to equipment installation with owner.
7. Coordinate Owner-desired camera views, providing camera modeling prior to installation.
8. Coordinate Camera housing and mount finishes with Architect and Owner.

Install and wire equipment in accordance with University of Kentucky ITS Standards, manufacturer’s recommendations, and accepted engineering and installation practices.

Mount system components as recommended by manufacturer. All equipment mounting in Communication Closets must be approved by UK ITS prior to installation.

9. Arrange equipment to facilitate permanent access for use and maintenance.

3.2 CABLE INSTALLATION

Neatly lace, dress, and support cabling.

Pull cables in accordance with cable manufacturer's recommendations and ANSI/EEE C2 Standards as well as University of Kentucky ITS Standards and all Division 270000 requirements.

1. Do not exceed manufacturer's recommended pulling tensions.
2. Do not install bruised, kinked, scored, deformed, or abraded cable.
3. Do not splice cable between indicated termination, tap, or junction points.
4. Remove and discard cable where damaged during installation and replace it with new cable.
5. Pull all cable by hand unless installation conditions require mechanical assistance.

Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.

Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications in camera location.

6. Loosely coil slack in “Figure-eight” in a manner that prevents kinking.
7. Loop radius shall be at least 4X minimum bend radius for cable.
8. Slack length of cable shall be 4 feet (minimum).

Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of Video System.

Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with Engineer.

At no time shall any cable be subjected to a bend less than manufacturer’s specified minimum radius. Also refer to UKITS Standards.

Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.

Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers’ recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

3.3 IP VIDEO CAMERAS

Mount Video Cameras per project drawings.

Field-verify exact locations and field-of-views with Owner prior to installation.

Provide video camera lenses to accommodate Owner-coordinated field-of-view per camera.

1. Field verify and confirm views with Owner prior to procurement and final installation and adjust camera positions and lens sizes as required upon installation.

Configure resolution, frame rate, password, etc. to match existing system installation, coordinate with UKPD.

Coordinate with Owner prior to installation to confirm required parameters.

Wire interface(s) to external alarms.

3.4 NETWORK CONNECTION

Cross-connections to building LAN by Owner, NO EQUIPMENT MAY BE CONNECTED TO UK NETWORKS BY ANY SUB CONTRACTOR, ONLY BY UK ITS personnel.

3.5 LABELING AND IDENTIFICATION

Labeling protocols to match all UK Security System installations.

1. Cabling, Hardware, and Equipment shall be clearly labeled using a Code identifying each piece as unique throughout Video Camera System. This code will aid in identifying hardware for servicing and maintenance.
2. Labels and Tags shall be machine-generated using English character set in black ink on white background labels and Tags.

    a. Self-laminating permanent labels are required on cables; permanent non-marring labels are required on all other hardware/cabinets.
    b. No hand-written Labels or Tags shall be allowed.
    c. Dymo or Kroy type adhesive backed lettering is not acceptable.

Identify and tag all cables to denote function.

3. Tag shall indicate:

    a. System of which cable is a part,
    b. Indication of cable destination (e.g., room or component), and
    c. Unique alpha-numeric identifier that distinguishes cable from all others in system.

All labels shall be machine generated. Handwritten labeling is not acceptable.

Label all front panel controls used in normal operation of system using plastic laminate engraved labels or approved equal.

4. Firmly affix to panel or device.

Labeling Formats

5. To be defined by Owner prior to construction following practice for all campus Security System installations.

3.6 SYSTEM TESTING AND ACCEPTANCE

System shall be complete and fully operational before requesting final acceptance and scheduling system Integration into the Campus VMS.

Installation of all field devices will be inspected by Owner or Owner's representative. Inspection will consider overall neatness and quality of installation, functionality of each individual device, mounting, wiring and labeling.

Conduct a seven-day burn-in test. Intent of burn-in test shall be to prove System by placing it in near real operating conditions prior to connection to Campus VMS.

1. During this period System shall be fully functional and programmed so that all points, controls, messages, prompts, etc. can be exercised and validated.

Provide written notification to Owner that system is completely installed, integrated, burn-in testing completed and is fully functional as specified herein.

2. Submit schedule for acceptance testing. Representatives of Owner, UKPD and/or representative may witness test procedures.
3. Notify Owner UKPD and the representative in writing a minimum of two weeks in advance to allow for such participation.
4. Describe test procedures prior to testing and submit sample test form to Owner / Representative.

Prior to final acceptance test, equipment rooms and similar areas should be free of accumulation of waste materials or rubbish caused by operations under Contract.

Equipment shall be on and fully operational during any and all testing procedures.

5. Provide all personnel, equipment, and supplies necessary to perform site testing.

6. Supply a form of communication with remote parties in the team for use during test.
7. A manufacturer's representative shall be present on site to answer any questions that may be
   beyond technical capability of Contractor's employees, if Contractor so elects or by specific request of Representative Owner, at no charge to Representative or Owner.

During course of final acceptance test, Contractor shall be responsible for demonstrating that, without exception, provided VMS complies with contract requirements.

Testing shall include but not be limited to:

8. Continuity and conductor/connector integrity on all cables.
9. Demonstrate functionality of all cameras including:
   a. Owner-acceptable field of view.
   b. Response to alarms.
   c. Response to Access Control System inputs.
10. Confirm remote viewing, configuration, and camera control via Browser and in the UKPD Operations Center. Confirm all Analytic uses on Cameras programmed for Analytic use.
    a. Confirm system rights settings for authorized users.
11. Demonstrate storage and retrieval of recorded video by date/time.

Owner retains the right to suspend and/or terminate testing at any time when system fails to perform as specified.

12. In event it becomes necessary to suspend test, Contractor shall work diligently to complete / repair all outstanding items to condition specified in Specification and as indicated on Security Drawings.
13. All Owner's / Representative Fees and expenses related to suspended test will be deducted from Contractor's retainage.
14. Contractor shall supply Owner with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest.
15. During final acceptance test, no adjustments, repairs, or modifications to system will be conducted without permission of Owner.

Upon successful completion of final acceptance test (or subsequent punch list retest) Owner or Representative will issue a letter of final acceptance.

Records of Test Results shall be included in System Documentation and submitted as detailed below.

3.7 OWNER TRAINING

Training course for system covered in this section shall be a minimum of 6-hours.

Maximum number of students to be (6).

1. Training materials shall be provided to all students.

Record, label, and catalog all training on DVD Videodiscs. Provide discs to Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for taping all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.

Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been completed.

3.8 DOCUMENTATION

All Owners manuals and or maintenance information shall be provided in printed form as well as electronic PDF format to the owner and owner representative.

3.9 WARRANTY AND SUPPORT

Unless otherwise noted, Contractor shall guarantee all materials, equipment, etc., two (2) years from date of final Owner acceptance of system. This guarantee shall include all labor, material, and travel time.

Contractor/Integrator and/or manufacturer(s) of system equipment must offer:

1. Technical Support Capabilities (Technician onsite) response time onsite within 4 hours, 24-hours/7-days per week (“24/7”), and 365 days per year.
2. 24-hour turn-around (from receipt of item) for Repair or Replacement of failed components, 7-days per week.

END OF SECTION 282300

SECTION 312000A - EARTH MOVING – FINAL GRADING

PART 1 GENERAL

1.01 DESCRIPTION

A. Perform earthwork as shown and specified. The work includes:

1. Site grading and filling to indicated elevations and contours.

2. Subgrade preparation for site walls, curbs, stairs, walks and paving.

3. Finish grading.

B. Related Work:

1. Section 329113: Planting Soil Systems (Structural Soil)

2. Section 329115: Soil Preparation and Mixes

3. Section 329210: Turf and Grasses.

4. Section 329310: Exterior Planting.

5. Section 334100: Storm Utility Drainage Piping.

1.02 QUALITY ASSURANCE

A. Testing and inspection: Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in geotechnical and soils engineering.

C. Owner shall provide and pay for testing and inspection during earthwork operations as part of Special Inspections. The Contractor shall facilitate and cooperate with the Special Inspector.

D. Materials and methods of construction shall comply with the following standards:

1. Kentucky Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
2. American Society for Testing and Materials, (ASTM).
3. American Association of State Highway and Transportation Officials, (AASHTO).
4. National Fire Protection Association, (NFPA).
5. Revised Report of Geotechnical Exploration by Solid Ground Consulting Engineers, PLLC. dated August 1, 2023.

E. Special Inspections for existing site soil conditions, fill placement and load-bearing requirements shall be as required by Section 1704 of the International Building Code (IBC). The approved soils report and the documents prepared by the registered design professional in responsible charge shall be used to determine compliance. During fill placement, the special inspector shall determine that proper materials and procedures are used in accordance with the provisions of the approved soils report. The following require verification and inspection of soils:

1. Verify materials below footings, pavements and walks are adequate to achieve the design bearing capacity: Periodically during task listed.
2. Verify excavations are extended to proper depth and have reached proper material: Periodically during task listed.
3. Perform classification and testing of controlled fill materials: Periodically during task listed.
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of controlled fill: Continuous during task listed.
5. Prior to placement of controlled fill, observe subgrade and verify that site has been properly prepared: Periodically during task listed.

1.03 SUBMITTALS

A. Facilitate and cooperate with Special Inspection personnel for collection of samples of materials proposed for use.

B. Special Inspection engineer shall submit reports and certifications for testing and inspection of the following:

1. Fill and backfill materials.

2. Compaction operations.

3. Foundation excavations and footing subgrade.

1.04 PROJECT CONDITIONS

A. Known underground and surface utility lines are indicated on the drawing. Contractor is responsible for verifying location of existing utilities.

B. Protect existing trees and other features designated to remain as part of the landscaping work.

C. Protect excavations by shoring, bracing, sheeting, underpinning, or other methods, as required to prevent cave-ins or loose dirt from entering excavations. Barricade open excavations and post warning lights at work adjacent to public streets and walks.

D. Underpin adjacent structure(s), including utility service lines, which may be damaged by excavation operations.

E. Promptly repair damage to adjacent facilities caused by earthwork operations. Cost of repair at Contractor's expense.

F. Promptly notify the Architect of unexpected sub-surface conditions.

G. Protect bottoms of excavations and soil beneath and around foundation from frost and freezing.

H. Grade at excavations to prevent surface water draining into excavated areas. Provide ditches or berms to direct surface runoff to locations where it can drain into storm sewer system or be collected and pumped from construction site.

PART 2 PRODUCTS

2.01 MATERIALS

A. All fill material is subject to testing and inspection.

B. Fill materials: Inert subsoil material free of organic matter, rubbish, debris, and rocks greater than 3" diameter and meeting the following requirements:

1. Plasticity index of not more than 30 with a maximum dry density (ASTM D698) greater than 100 pcf.

2. Moisture content of compacted fill shall be maintained at plus 2 percent to minus 2 percent of optimum moisture.

3. Provide and utilize off-site borrow fill material when borrow fill is required to complete the work. Verify suitability of off-site borrow fill material and locations with the Geotechnical Engineer prior to transporting the material to the site.

4. Proposed fill material shall be inspected and tested prior to use in the work.

5. Suitable excavated materials (Lean clay as identified in Geotechnical Report) removed to accommodate new construction may be used as fill material subject to Geotechnical Engineer's inspection and approval. Fat clay that occurs beneath the lean clay on site may remain as long as it does not occur within 3 feet of the sub-grade of building footings or slabs. Fat clays excavated on site may be used as fill in areas outside of the building footprint if they are placed at elevations in excess of 3 feet below sub-grade and compaction requirements can be met. Excess material and unsuitable material shall be wasted off-site at the Contractor’s expense.

C. Granular base: Dense graded aggregate for fill beneath building footings and slabs as noted on plans and details.

D. Granular fill: AASHTO M43, #2, #57 or #9 clean uniformly graded stone or gravel as noted on plans and details.

E. Rip rap: Round carbonate stones or fragmented carbonate rock, dense, sound, and free of cracks or seams, shale, clay, friable materials and debris, placed at thickness indicated on plans. Provide all rip rap materials as required to complete the work.

F. Geotextile filter fabric: KYDOH type IV non-woven soil separator.

G. Silt fence: Propex (formerly Amoco) 2130 or equal.

H. Other materials required for proper completion of work: As selected by Contractor and acceptable to Architect.

PART 3 EXECUTION

3.01 PREPARATION

A. Establish extent of grading and excavation by area and elevation. Designate and identify datum elevation and project engineering reference points. Set required lines, levels, and elevations.

B. Do not cover or enclose work of this Section before obtaining required inspections, tests, approvals, and location recording.

3.02 EXISTING UTILITIES

A. Before starting grading and excavation, establish the location and extent of underground utilities in the work area by contacting utility companies. Exercise care to protect existing utilities during earthwork operations. Perform excavation work near utilities by hand and provide necessary shoring, sheeting, and supports as the work progresses. Damage to utilities will be repaired immediately in a continuous effort until complete at the Contractor's expense.

B. Maintain, protect, relocate, or extend as required existing utility lines to remain which pass through the work area. Pay costs for this work, except as covered by the applicable utility companies.

C. Protect active utility services uncovered by excavation.

D. Remove abandoned utility service lines from areas of excavation. Cap, plug, or seal abandoned lines and identify termination points at grade level with markers.

E. Accurately locate and record abandoned and active utility lines rerouted or extended on project record documents.

3.03 SITE GRADING

A. Perform grading within contract limits, including adjacent transition areas, to subgrade of new elevations, levels, profiles, and contours indicated. Provide subgrade surfaces parallel to finished surface grades. Provide uniform levels and slopes between new elevations and existing grades.

B. Grade surfaces to assure areas drain away from structures and to prevent ponding and pockets of surface drainage. Provide subgrade surfaces free from irregular surface changes and as follows:

1. Rough grading: Plus or minus 0.10 ft. subgrade tolerance. Finish required will be that ordinarily obtained from either blade-grader or scraper operations.

2. Provide subgrade surface free of exposed gravel or stone exceeding 3" in greatest dimension in paved areas or 1" in lawn and planting areas. Areas with concentrated amounts of stone of any size including smaller than 1", such as stockpile/staging areas, edges of pavement or utility trenches, shall be raked clean of stone prior to placement of topsoil.

3. Paved areas: Shape surface of subgrade areas to line, grade, and cross-section indicated. Provide compacted subgrade suitable to receive paving base materials. Subgrade tolerance plus 0, minus 1/2".

4. Granular base: Grade subgrade surface smooth and even, free of voids to the required subgrade elevation. Provide compacted subgrade suitable to receive granular base materials. Tolerance 1/2" in 10'-0".

C. Grading at existing trees to remain:

1. Perform grading, within branch spread of existing trees to remain, by hand methods to elevations indicated.

2. Cut roots cleanly to depth 3" below proposed finish grade. Coat cut roots with tree paint.

3.04 EXCAVATING

A. Previous Bid Package performed mass excavation to subgrades for building footing and slabs. This bid package requires excavation and fill to subgrade for site pavements, walkways, landscape areas, etc. Perform additional excavation to install underground detention system and as necessary to meet elevations indicated on the Grading Plan for all remaining site elements. Remove fat clay soils from within 3 feet in depth beneath walkways and pavements. Fat clay soils may remain at depths in excess of 3 feet deep beneath subgrades. Contractor shall segregate stockpiles of fat clays from lean clays. No room is available on site for soil stockpiling. Contractor shall stockpile soil at off-site locations that cannot be immediately placed in required fill areas due to construction sequencing. Contractor shall stockpile excavated materials necessary for fill required and haul away and dispose of any excess material at the completion of earth moving operations (including any material stockpiled by previous bid packages).

B. Excavate to subgrades indicated on the plans. Obtain inspection and testing of subgrades for paving.

C. Earth excavation shall include the satisfactory removal and disposal of all materials encountered, regardless of the nature of the materials, the condition of the materials at the time they are excavated, or the manner in which they were excavated. **All excavation shall be unclassified.**

D. Unauthorized excavation: Backfill and fill all over excavation to proper grades. Fill over excavation at footings with 1,500 psi concrete. Additional labor and material for unauthorized excavation and remedial work at Contractor's expense.

E. Shore, sheet, or brace excavations as required to maintain them as secure from caving. Remove shoring and bracing as backfilling progresses, when banks are safe against caving.

F. The use of explosives is not permitted.

G. When necessary, cut away rock in bottom of excavations to form level beds that follow natural strata. Form with sharp steps when steps are required. In utility trenches, excavate 6" below invert elevation of pipe and 24" wider than pipe diameter, minimum 36" trench width. Remove loose materials to sound base.

H. Existing storm and sanitary sewerage: Where existing sewers pass beneath new paving, remove existing earth fill to the top of the sewer pipe or to a depth as directed by the Geotechnical Engineer. Install an approved backfill material compacted in maximum 8" layers. Extend compacted fill from top of sewer pipe to proposed paving subgrade elevation.

3.05 DRAINAGE

A. Provide necessary pumps and drainage lines and maintain excavations, including footings, basements and pits, free from water, ice and snow during excavating and subsequent work operations.

B. Provide drainage of the working area at all times.

3.06 FILLING, BACKFILLING, AND COMPACTING

A. Obtain inspection and approval of subgrade surfaces by Geotechnical Engineer prior to filling operations. Scarify, dry, and compact soft and wet areas; remove and replace unsuitable subgrade materials with an approved compacted fill material. Take corrective measures before placing fill materials.

1. Topsoil not permitted as fill or backfill material within structure limits or under paved areas.

B. Spread approved fill material uniformly in layers not greater than 8" of loose thickness over entire fill area.

1. Lift thickness requirements may be modified by Geotechnical Engineer to suit equipment and materials or other conditions when required to assure satisfactory compaction.

2. Moisture-condition fill material by aerating or watering and thoroughly mix material to obtain moisture content permitting proper compaction.

3. Place and compact each layer of fill to indicated density before placing additional fill material. Repeat filling until proposed grade, profile, or contour is attained.

4. Suspend fill operations when satisfactory results cannot be obtained because of environmental or other unsatisfactory site conditions. Do not use muddy or frozen subgrade surface. Do not place fill material on muddy or frozen subgrade surface.

5. Maintain surface conditions, which permit adequate drainage of rainwater and prevent ponding of surface water in pockets. When fill placement is interrupted by rain, remove wet surface materials or permit to dry before placing additional fill material.

C. Filling at existing trees to remain: No fill shall be permitted within the dripline of existing trees to remain.

D. Place backfill materials in uniform layers not greater than 8” loose thickness over entire backfill area and compact each lift properly. Backfill shall be placed in uniform layers not greater than 4" loose thickness over areas where compaction is achieved with hand compactors or manual means.

E. Fill all areas of settlement to proper grade before subsequent construction operations are performed.

F. Compaction:

1. Provide compaction control for all fill and backfill.

2. Compact top 12" of subgrade and each layer of fill or backfill material for future foundations and floor slabs to 98% of maximum dry density at optimum moisture content in accordance with ASTM D698 Standard Proctor Method. Extend compaction at least 5'-0" at both sides of foundations.

2. Compact top 12" of subgrade and each layer of fill or backfill material at future paved areas to 95% of maximum dry density at optimum moisture content in accordance with ASTM D698 Standard Proctor Method. Extend compaction at least 1-0" beyond slabs-on-grade and paving.

3. Compact top 6" of subgrade and each layer of fill material at future lawns and unpaved areas to 85% of maximum dry density at optimum moisture content in accordance with ASTM D698 Standard Proctor Method.

4. Water settling, puddling, and jetting of fill and backfill materials as a compaction method are not acceptable.

5. Maintain moisture content of materials, during compaction operations within required moisture range to obtain indicated compaction density.

6. Provide adequate equipment to achieve consistent and backfill materials.

3.08 EROSION CONTROL

A. Provide erosion control measures as indicated on plans including installation of silt fencing, installation of silt check inlet controls with specified materials.

1. Install silt fence in areas indicated on plans to conform with specified details. Silt fencing shall be installed prior to all grading activity.

B. Contractor shall provide continual maintenance of erosion control structures, including but not limited to:

1. Removal of silt, trash, mud, debris from ditches, channel and from silt fences.

2. Replacement of silt fence that has been damaged or destroyed.

C. Contractor shall keep all public roads free of silt, dirt, mud and debris throughout the entire project. Contractor shall remove and clean any silt, dirt, mud and debris from roadways at their expense.

E. Contractor shall thoroughly read and comply with all aspects of the SWPPP plan. The plan includes certifications that must be signed and submitted by the contractor and appropriate sub-contractors prior to approval of the first application of payment.

F. The Contractor shall be named a co-permittee of the KPDES or General KYR10 Permit and shall agree to the following certification:

“I certify under penalty of law that I understand the terms and conditions of the general Kentucky Pollutant Discharge Elimination System (KPDES) or General KYR10 Permit that authorized the storm water discharges associated with industrial activity from the construction site identified as part of this certification.”

The Contractor shall be responsible for preparing and submitting the Notice of Intent to governing agency 30 days prior to site disturbance.

3.09 FINISH GRADING

A. Topsoil shall be provided from off-site and meet the specifications in sections 329113 and 329115.

B. Prior to finish grading, remove all 1” size and larger gravel from top 6” of subgrade soil in lawn areas and planting bed or tree planting areas. Make certain that areas with concentrated amounts of stone of any size including smaller than 1”, such as stockpile/staging areas, edges of pavement or utility trenches, have been raked clean of stone prior to placement of topsoil. Topsoil mixes shall be placed during dry weather. Do not grade topsoil with equipment that will over compact topsoil preventing the adequate root growth of proposed turf/plants. Bulldozers and backhoes are not suitable for the final step of finish grading. Tractors or skid steers with box graders shall be used to groom the soil and remove the clods and rocks.

C. Fine grade topsoil eliminating rough and low areas to ensure positive drainage. Maintain levels, profiles, and contours of subgrades.

D. Remove stones, roots, weeds, and debris while spreading topsoil materials. Rake surface clean of stones 1" or larger in any dimension and all debris. Provide surfaces suitable for soil preparation provided under lawn and planting work.

E. Landscape Architect shall be notified a minimum of 2 days prior to placement of topsoil so the subgrade may be inspected and the placement of topsoil by the Contractor may be observed.

F. Maintenance:

1. Protect finish graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and damaged areas.

2. Where completed areas are disturbed by construction operations or adverse weather, scarify, re-shape, and compact to required density.

3.10 FIELD QUALITY CONTROL

A. Contractor shall provide adequate notice, cooperate with, provide access to the work, obtain samples, and assist testing agency and their representatives in execution of their function.

B. Fill materials: Test proposed materials to verify suitability for use, gradation of material, moisture-density relation by ASTM D698 Standard Proctor Method, design bearing value, and percent of organic materials.

C. Subgrade surfaces: Based on visual examination at the site, provide bearing tests as required to verify questionable subgrade surfaces are adequate and meet or exceed design bearing values.

1. Structure slabs and paved areas: Make at least 1 test for each 2,000 sq. ft. of questionable surface.

D. Compaction operations: Coordinate full-time inspection and testing during filling and compaction operations. Test each lift to fill to verify compaction meets specified requirements. Provide periodic inspection and testing during site area filling and compaction operations.

1. Future structure slabs and paved areas: Make at least 1 test for each 5,000 sq. ft. of each 8” thick fill lift. A minimum of two tests per each lift are required.

2. Future foundation wall and retaining wall backfill: Make at least 2 tests at locations and elevations directed by the Geotechnical Engineer.

E. When, during progress of work, field tests or observations indicate that installed compacted materials do not meet specified requirements, provide additional compaction until specified density is achieved, or remove and replace defective materials with new materials as directed by the Geotechnical Engineer. Cost of additional labor, materials, and testing to attain specified density shall be provided at Contractor's expense.

3.11 DISPOSAL OF WASTE MATERIALS

A. Stockpile, haul from site, and legally dispose of waste materials, including deleterious soil, trash, and debris.

B. Maintain disposal route clear, clean, and free of debris. Disposal in any floodplain is not allowed.

3.12 CLEANING

A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for site work operation.

END OF SECTION 312000

SECTION 315000 - TEMPORARY RETENTION SYSTEM, BRACING, AND UNDERPINNING

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. Provide and install all components of the temporary retention system (TRS), bracing and underpinning as may be required by existing conditions.
2. This Contractor shall design and provide all plans, labor, materials, equipment and services, and perform all operations necessary for and incidental to the furnishing, installation and maintenance of the TRS, bracing and underpinning systems.
3. Extent and sequencing of work required by this Section shall be coordinated with the Construction Manager and Excavation Contractor.

B. Related Sections:

1. Section 312000 - Earthwork.

1.3 DESCRIPTION

A. All work of this Section shall be executed on a performance basis.

B. Design, provide, monitor and maintain a temporary retention system where shown on the drawings, and at other locations if necessary, to complete the mass excavation for the project.

1. The TRS shall be capable of resisting all soil and surcharge loads, including those produced by construction equipment for future building construction.
2. Walers and tiebacks shall be located to clear all permanent construction. Coordinate tiebacks with location of all existing utilities, foundations, and other existing obstructions.
3. The maximum height of unsupported excavations shall be determined by site conditions and lateral earth and surcharge loadings such as to prevent loss of soil and/or movement of existing structures, pavements, utilities or property.
4. Tiebacks, if used, shall be installed at elevations indicated on the Contractor's working drawings, and shall be successfully tested by this Contractor before the excavation is taken to a greater depth.
5. The TRS is intended to be at least six feet clear of the foundation walls to allow for installation and removal of formwork and installation of waterproofing.

C. If necessary, underpin, shore or brace existing foundations or other improvements where necessary to complete the excavation for the project. Underpinning shall reestablish solid bearing on existing soil for entire width of footing.

D. Install excavation support and protection systems without damaging existing buildings, pavements, utilities and other improvements adjacent to excavation.

1.4 QUALIFICATIONS

A. This Contractor shall have a minimum of five years of experience in the type of work required by this Section, and within the past five years shall have successfully installed at least two retention systems of the type, size, depth, and conditions proposed for this project.

B. This Contractor shall submit evidence of his experience and have at least one Registered Professional Engineer licensed in the state where this project is located.

C. This Contractor shall have on his staff a supervising engineer for this project having at least five years of design and construction experience in the type of work required by this Section.

D. This Contractor shall have a foreman or superintendent experienced in the type of work required by this Section who will be present while this work is being performed.

E. This Contractor shall engage a Professional Surveyor licensed in the state where this project is located to perform surveys, layouts and measurements for the work of this Section.

1.5 PROJECT CONDITIONS

A. A subsurface investigation has been made and the results are available in the form of a Geotechnical Engineering Report for the project, prepared by the Owner's Geotechnical Engineer and is available for bidders to review. This information was obtained primarily for use in preparing the foundation design, and for evaluating existing conditions that may affect this Contractor's work.

1. Data on indicated subsurface conditions are not intended as representatives or warranties of continuity of such conditions. It is expressly understood that the Owner, Construction Manager, and Architect/Engineer will not be responsible for interpretations or conclusions drawn there from by the Contractor.
2. Data is made available for the convenience of the Contractor and is not guaranteed to represent conditions that may be encountered, nor is it to be included as part of the Contract Documents.
3. It is required that all Contractors or Subcontractors submitting bids for this part of the Work visit the site and make whatever additional investigations, including drilled test holes, they deem necessary to prepare their bids. All additional investigation work requires approval and coordination with the Owner. All test holes shall be filled immediately after investigation is completed to the satisfaction of the Owner. All additional investigations, including drilled test holes, test pits, etc., shall be paid for by the Contractor.

B. Prior to the execution of this work, this Contractor, Construction Manager, Architect and a representative from the Owner shall jointly survey the condition of adjoining structures and properties. Photographs and records shall be made of any prior settlement or cracking of structures, pavement and the like, that may become the subject of possible damage claims.

C. The Contractor is responsible for field locating and verifying the location of all existing utilities before starting the work. Maintain uninterrupted service for utilities designated to remain in service. Notify Construction Manager and Architect of any utility locations different from that shown on the plans.

D. Components of the TRS and bracing systems may penetrate areas of natural soils and fill. Debris, buried foundations and walls, abandoned piles and lagging from past construction, other obstructions, and water may be encountered. Contractor shall, within the Base Bid, be responsible for penetrating all obstructions, preventing caving of soils surrounding holes, and providing water protection and dewatering if necessary.

E. Prior to completion of the project, all components of the TRS and bracing systems (soldier beams and lagging, sheeting, etc.) located within the upper six feet of the public right of way shall be removed. Tieback anchors located within the upper 15 feet of the public right of way shall be de-tensioned.

1.6 DESIGN CRITERIA

A. The TRS, bracing, and underpinning systems, shall be designed by this Contractor to safely support all earth and surcharge pressures, including those from existing buildings and construction equipment, without deflections or settlements that may damage adjacent structures, pavements, utilities or property.

B. This Contractor shall coordinate with the Construction Manager the location and weight of all construction equipment producing surcharge loads on the work of this Section.

C. Lateral pressure diagrams for use in the design of the TRS and bracing systems shall be submitted for review and acceptance of the Geotechnical Engineer.

D. Design, installation, and testing of tiebacks shall be in accordance with Post-Tensioning Institute (PTI) DC35.1 Recommendations for Prestressed Rock and Soil Anchors.

E. Refer to the Geotechnical Report and, if necessary, consult with the Geotechnical Engineer for additional information and recommendations for the design of the TRS and bracing systems. All fees for geotechnical engineering assistance shall be paid by the Contractor.

1.7 SUBMITTALS

A. Prior to starting work, submit for record calculations and working or shop drawings showing each proposed method of supporting adjacent earth and structures (i.e., retention system and tiebacks, sheeting, underpinning, other methods of bracing, etc). The drawings shall include the following:

1. Lists of materials to be used, including design mixes and mill tests.
2. Sequence of operations.
3. Detailed sections clearly illustrating the scope of work.
4. Relationship of components (soldier beams, piles, sheeting, tiebacks, etc.) to new and existing construction.
5. Location of utilities and streets.
6. Procedures and details of all testing.
7. Proposed methods and details for monitoring the performance of the TRS.

B. Drawings and calculations containing the information indicated above shall be prepared under the direct supervision of a qualified Professional Engineer registered in the state where the project is located, and who meets the qualifications outlined herein. The drawings and calculations shall bear this Professional Engineer's seal and signature.

C. The Architect/Engineer's review of the Contractor's working drawings and calculations will be for general compliance with the project scope only. The Contractor is solely responsible for the design and performance of the TRS, bracing and underpinning.

1.8 QUALITY CONTROL AND ASSURANCE

A. The Contractor shall confirm in writing with the Geotechnical Engineer the lateral earth pressure diagrams used for design of the TRS and bracing systems.

B. Construction Monitoring:

1. Construction monitoring will be performed by the Owner's independent Testing Agency.
2. Testing Agency will conduct, monitor, and report results of tests and inspections required under this Section.
3. Testing Agency will observe all TRS operations and perform the following:
   a. Review Contractor's calculations and drawings.
   b. Monitor the performance of the TRS, including measurement of the lateral deflection at the top on not less than a bi-weekly basis. The first reading will be taken before any earth is excavated adjacent to the retention system. The system will be monitored until walls are backfilled.
4. Testing Agency will monitor installation of bracing and underpinning work of this Section.

1.9 WARRANTY

A. Restore and repair to the Owner's satisfaction all structures, pavement, utilities and property damaged due to movement of the TRS, bracing or underpinning.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Tieback anchor materials shall be fabricated in accordance with PTI DC35.1 Recommendations for Prestressed Rock and Soil Anchors.

B. Cast-in-place concrete, including reinforcement and testing, shall comply with American Concrete Institute (ACI) 301 Specifications for Structural Concrete.

1. Concrete for underpinning shall be made with high early strength cement.
2. Grout for underpinning shall be non-shrink.

C. Structural steel components shall comply with American Institute of Steel Construction (AISC) 360 Specification for Structural Steel Buildings.

D. Wood lagging shall be of sufficient size and quality to retain the calculated earth pressures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. This Contractor shall examine areas and conditions under which the work is to be performed. Notify Construction Manager of conditions detrimental to proper and timely completion of the Work.

B. Starting of work constitutes acceptance of existing conditions and substrates.

3.2 PREPARATION

A. Before drilling or driving, verify locations of underground utilities with the utility companies, Owner and Construction Manager. Excavate or survey to establish exact utility locations where necessary. Coordinate all work with the utilities to assure their uninterrupted function.

3.3 PROTECTION

A. Where active utilities are encountered but not shown on Drawings, the Construction Manager, Utility Owner, Architect and Owner shall be notified; and work shall be protected, supported, or relocated as directed. Repair damaged utilities to the satisfaction of the Utility Owner, Owner, and Construction Manager.

B. Inactive and abandoned utilities encountered shall be reported to the Construction Manager and Owner. The utilities shall be removed, plugged or capped as directed by the Utility Owner. In absence of specific requirements, plug or cap such utility lines as required by local regulations.

3.4 TIEBACKS

A. Drill for, install, tension, and grout tiebacks into position. Test load-carrying capacity of each tieback before taking excavation to a greater depth.

B. Replace and retest deficient tiebacks.

3.5 INSTALLATION OF UNDERPINNING

A. After excavation, thoroughly clean contact surface of underside of existing foundations. Bring underpinning concrete up to within 4” of bottom of existing foundations and fill remaining space with grout. Make grout as dry as possible and pack firmly, leaving no voids.

B. Underpinning shall be placed sequentially in such a manner to maintain the safety and stability of the excavation and existing construction.

3.6 COORDINATION WITH OTHER OPERATIONS

A. Installation and sequencing of the TRS, bracing and underpinning work shall be coordinated with the work of all other trades affected by this work, such as demolition, excavation, foundations, and other operations.

3.7 WASTE REMOVAL

A. Remove from the site and legally dispose of all waste material resulting from or caused by the work of this Section.

END OF SECTION

SECTION 316320 - DRILLED PIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes all labor, material, equipment, special tools and services required to complete all drilled pier work, as herein specified, and as indicated on the Drawings, including but not limited to:

1. Drilling and excavation of pier shafts.
2. Metal casings or shells.
3. Protection of shaft openings.
4. Removal of steel casings or shells.
5. Removal of excavated materials.
6. Concrete and reinforcement for drilled piers.
7. Probe holes at all piers as noted on the drawings, include cost in base bid.

B. Related Sections:

1. Section 033000 - Cast-in-Place Concrete.
2. Section 312000 - Earthwork.

C. Unit prices:

1. Drilled Pier Work shall be on a lump sum basis, based on the sizes and total lengths of drilled piers shown on the Drawings.
2. Unit prices per linear foot for each shaft diameter shall be provided as set forth in the Bid Form for adjustment of Contract Sum by Change Order to reflect net difference between total of design lengths and actual length of piers installed.
3. These unit prices shall apply to both net overages and underages and shall include the costs of drilling, casing, cleaning, concreting, reinforcing, and all other costs associated with the change in footage.
4. Provide separate unit costs for the length of drilled piers installed in rock and the length of drilled piers installed above the rock sockets specified herein and indicated on the Drawings.
5. No payment will be made for increases in concrete volume due to causes other than length change.
6. No payment will be made for over-drilling not directed by the Geotechnical Engineer. Fill the extra depth with concrete if all other conditions are satisfactory.
7. Include a unit price for additional probe holes.

1.3 REFERENCES

A. Comply with the provisions of the latest edition of the following codes, specifications and standards unless a date is indicated. Modifications in this specification, when in conflict with the referenced codes, specifications and standards, shall take precedence.

1. Kentucky Building Code (KBC).

2. ACI (American Concrete Institute) 336.1-01: Specification for the Construction of Drilled Piers Structures is hereby incorporated as part of this Section. Supplemental requirements and modifications listed herein take precedence over the requirements of ACI 336.1. All ACI 336.1 items unless modified by the Contract Documents are incorporated as written. When any part of any item is modified or voided, the unaltered provisions of the part shall apply as written.
3. ACI 301-16: Specifications for Structural Concrete.
4. CRSI (Concrete Reinforcing Steel Institute) Manual of Standard Practice, 29th Edition.

B. A copy of each reference shall be kept in the project's field office at all times. They shall govern the work except as herein modified.

1.4 SUBMITTALS

A. Submit documentation to demonstrate compliance with the Contractor qualifications noted below. Include experience record of supervisory personnel and drillers.

B. Submit written description of equipment and techniques proposed for use, and names of three similar projects completed by installer in last three years.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Submit plan layout of drilled piers along with reinforcing steel shop drawings.

E. Submit proposed concrete mix design per Section 033000 – Cast-in-Place Concrete.

F. Submit a quality control program per ACI 336.1.

G. At regular intervals, the Geotechnical Engineer's Representative will submit drilling logs to the Owner, Architect/Engineer, Contractor, and Construction Manager with the following information:

1. Identification mark.
2. Shaft diameter.
3. Bottom elevation.
4. Top elevation.
5. Bearing strata description.
6. Depth of penetration in bearing strata.
7. Length and location of any permanent casing.
8. Nature and location of obstructions, including durations.
9. Water conditions during drilling and concrete placement.
10. Deviation from design centerline location and deviation from plumb.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Drilled piers shall be installed by a specialty Contractor with a minimum of ten years of experience in drilled pier construction.
2. Personnel performing the work shall have experience with similar subsurface materials, water conditions, pier sizes, and special techniques required.
3. Contractor shall have successfully completed at least five contracts with similar type soils, bearing stratum, pier diameters and project size.

B. Contractor shall engage a Kentucky-registered surveyor to perform surveys, layouts, and measurements for drilled pier work. Coordinate with services of Geotechnical Engineer's Representative.

C. Comply with ACI 336.1.

D. Comply with applicable laws, ordinances, and the Kentucky Building Code.

E. A Representative of the Owner's Geotechnical Engineer will conduct construction review services to monitor all drilled pier work, examine prepared bearing surfaces, and establish the final installation elevation to which pier bottoms are to be drilled.

F. Testing of concrete in the field will be performed by the Geotechnical Engineer's Representative or a separate independent Testing Agency retained by the Owner.

G. The Contractor shall select and employ an independent testing agency, subject to the Architect/Engineer's approval, to perform all testing required by the Contractor for qualification of proposed materials, establishment of mix designs, and for all other testing services needed or required by the Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pier casings and reinforcing steel above ground on platforms.

B. Protect materials from damage, exposure and corrosion.

C. Drilled pier casings or shells ordered and delivered to the site prior to verification of the assumed working capacities and establishment of criteria for excavating piers shall be at the risk of the Contractor.

1.7 PROJECT CONDITIONS

A. Geotechnical information:

1. Subsurface Information: A report of the subsurface investigation for the project, prepared by the Owner's Geotechnical Engineer, is available to bidders for review.
2. Data on indicated subsurface conditions are not intended as representatives or warranties of continuity of such conditions. It is expressly understood that Owner and Architect/Engineer will not be responsible for interpretations or conclusions made by the Contractor.
3. Data is made available for the convenience of the Contractor and is not guaranteed to represent conditions that may be encountered.
4. It is required that all Contractors or Subcontractors submitting bids for this part of the Work visit the site and make whatever additional investigations, including drilled test holes, they deem necessary to prepare their bids. All test holes shall be filled immediately after investigation is completed to the satisfaction of the Owner.
5. No claim for additional compensation or extension of Contract time will be allowed on account of subsurface conditions inconsistent with the data available except as provided elsewhere herein.

B. Drilled piers will penetrate natural soils, rock and fill. Areas of old pavement, limestone floaters, debris, other obstructions, voids, and water may be encountered. Contractor shall, within the Base Bid, be responsible for penetrating all obstructions, preventing all caving of soils surrounding holes, and providing all water protection and dewatering.

C. Drilled piers may be installed in close proximity to existing spread footings which are presumed to bear at shallow depths. Contractor shall advance casings as the holes are drilled and take other precautions as necessary to protect existing foundations located at high bearing elevations.

D. Existing Utilities: Locate existing underground utilities in areas of drilled pier installation. If utilities are to remain in service provide adequate support and protection. Refer to Drawings for additional utilities information.

E. Protection: Protect structures and other construction from damage caused by drilled pier operations.

1.8 SUPPLEMENTAL REQUIREMENTS AND MODIFICATIONS TO ACI 336.1

A. The following statements modify and supplement ACI 336.1. All unaltered parts of ACI 336.1 shall apply as written. The Section and paragraph numbers correspond to those in ACI 336.1.

SECTION 1 (ACI 336.1) – GENERAL REQUIREMENTS

1.6.1.1 Examine areas and conditions under which drilled pier work is to be performed. Notify Construction Manager of conditions detrimental to proper and timely completion of the Work. Starting of work constitutes acceptance of existing conditions.

1.6.1.2 Do not install drilled piers until required earthwork in the area in which the drilled piers are to be installed has been completed.

1.6.3.1 Before drilling, verify locations of underground utilities with the utility companies and/or Owner. Excavate or survey to establish exact utility locations.

1.6.3.1 Active utilities shown on the Drawings shall be adequately protected from damage. Where active utilities are encountered but not shown on the Drawings, the Construction Manager, Architect/Engineer and utility owner shall be advised; the work shall be protected, supported, or relocated as directed; and the Contract Sum adjusted.

1.6.3.2 Inactive and abandoned utilities encountered shall be reported to the Construction Manager and Architect/Engineer. Utilities shall be removed, plugged or capped as directed by the Architect/Engineer or utility owner. In absence of specific requirements, plug or cap such utility lines as required by the local regulations.

1.6.4.1 The Construction Manager shall arrange a pre-construction meeting to be held a minimum of one week before the scheduled start of drilled pier operations. The meeting shall be attended by the Drilled Pier Contractor, Construction Manager, Structural Engineer, Geotechnical Engineer, Testing Agency, and Drilled Pier Contractor's Surveyor. The purpose of the meeting is to review:

1. Drilled pier installation procedures.
2. Drilled pier inspection and material testing procedures.
3. Contractor's procedures for surveying and documenting locations of existing utilities adjacent to drilled piers.
4. Disposal of drilled pier spoils.

SECTION 2 (ACI 336.1) – PRODUCTS

2.2.3.1 Casings shall be a constant circular section with a minimum nominal inside diameter of shaft sizes called for on the Drawings.

2.3.1 Reinforcing steel shall comply with Section 033000 – Cast-in-Place Concrete and have a minimum yield strength of 60 ksi.

2.4.1.1 Concrete strength and mix design shall comply with Section 033000 – Cast-in-Place Concrete.

2.4.3.1 Slump of concrete placed in dry holes that are uncased or which have permanent casing shall be 5 in. plus or minus 1 in. Slump of concrete placed in holes with temporary casing shall be 7 in. plus or minus 1 in. If required, use high-range water-reducer in concrete to provide required slump without exceeding maximum allowable water-cementitious materials ratio specified in Section 033000 – Cast-in-Place Concrete.

2.7 Drilling equipment

2.7.1 Drilled piers shall be installed with portable drilling rigs equipped with two-way leveling and two-way horizontal positioning. Rigs shall have adequate power, weight and shaft length to meet Project requirements, and a minimum 500,000 inch-pounds of torque and 35,000 pounds of downward force.

SECTION 3 (ACI 336.1) – EXECUTION

3.1.1.1 If specified tolerances for plan location or plumbness are exceeded, provide at no additional cost to Owner corrective measures to compensate for the excess eccentricity. Do not proceed until proposed corrective construction methods have been submitted to and accepted by Architect/Engineer.

3.1.2 Location tolerance at cut-off shall be no greater than 1/24 of the specified shaft diameter or 3 in., whichever is less.

3.1.3 Out-of-plumbness of piers shall not exceed 1.5% of length, nor 12.5% of shaft diameter, nor 15 in., whichever is less.

3.1.5 Maximum slope of bottom of drilled pier shall be 1/4 in. per foot.

3.1.7.1 Tolerances for placing anchor bolts and other embedded items for structural steel work (Section 05 12 00) shall be in accordance with the AISC Code of Standard Practice for Steel Buildings and Bridges.

3.1.7.2 Tolerance on horizontal location of dowels placed in tops of drilled piers shall be plus or minus 1/4 in., based on Contract Document location.

3.1.8 Tolerance on vertical deviation of top surface of drilled piers shall be plus 1 in. to minus 3 in.

3.1.9 Tolerance on drilled pier reinforcement shall be plus or minus 1/2 in., horizontal and vertical, based on actual pier location.

3.2.1.1 Drilled piers shall extend a minimum of one pier diameter into competent bedrock that is approved by the Geotechnical Engineer for 85 ksf bearing, unless noted otherwise on the Drawings or as directed by the Geotechnical Engineer.

3.2.1.2 Drilled piers shall be minimum 10 feet long or four times the diameter of the pier, whichever is greater. Minimum length includes depth of the drilled pier cap.

3.2.1.3 Bottom elevations and bearing capacities and lengths of drilled piers as shown on Drawings and specified herein are estimated from available subsurface data. Actual

elevations, drilled pier lengths, and bearing capacities will be determined by Geotechnical Engineer from conditions found in excavations. Final evaluations and acceptance of data will be by Architect/Engineer.

3.2.2.1 Exercise care during drilling operations, so that soil will not slough or cave-in due to drilling. Distribute equipment loads to prevent cave-ins.

3.2.2.2 Protect drilled shaft openings from earth falling in due to drilling of adjacent shafts.

3.2.3 Each drilled pier shaft shall be inspected by Geotechnical Engineer's Representative to ensure that the drilled pier bears in suitable material and that the shaft is free of debris and water. Do not begin concrete work until shaft is inspected and approved.

3.2.3.2.1 Case and provide proper safety equipment for any shaft into which workmen or an inspector will enter.

3.2.5.1 Remove material likely to scale off walls of drilled piers and thoroughly clean bottom, removing all loose material.

3.2.5.2 Pump and remove all water encountered in the drilled pier shafts. Do not allow water to sit on bearing surfaces of pier. Remove any deteriorated bearing material before concreting.

3.2.6.1 Probe holes 2 to 4 inches in diameter are required at each drilled pier where noted on the drawings. Probe holes shall be installed by the Drilled Pier Contractor and shall extend a minimum of 10 feet and at least 2 pier diameters below the bearing surface. The Drilled Pier Contractor shall coordinate installation of the probe holes and recovery of rock core samples for review with the Geotechnical Engineer's Representative.

3.2.7.1 Dispose of all cuttings from the drilling operation off the Project site, unless otherwise directed by the Construction Manager.

3.2.8 Alternate drilling and concreting closely spaced piers. Do not drill a pier closer than 10 feet to an existing pier less than three days old.

3.2.9 All drilled shaft openings not immediately filled with concrete shall be temporarily protected with a metal lid, spot welded in place.

3.2.10 Record and maintain information pertinent to each drilled pier, including actual measurements of each drilled pier's horizontal axial location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other data as required. Make this information available to the Geotechnical Engineer's Representative for inclusion in the drilling log submittals.

3.4.7.1 Splicing of vertical reinforcing bars for the pier shafts, other than as approved by the Architect/Engineer, shall not be permitted.

3.4.10.1 Insert steel reinforcing cage and wedge in place immediately after drilling and inspection. Reinforcing cages shall be rigidly tied, accurately located in shaft and adequately blocked to maintain the location and clearance shown on the Drawings.

3.4.12 Protect exposed portions of dowels and anchor bolts from mechanical damage and exposure to weather. Band tops of dowel cages with 2 in. wide bright orange ribbons.

3.5.4.1 Place concrete immediately after approval by Geotechnical Engineer's Representative and installation of reinforcing. Concrete to be placed the same day the shaft excavation is completed.

3.5.6.1 Place concrete to avoid segregation. In dry holes (defined as 1/4 inch or less rise per minute in groundwater at bottom of hole with total depth no greater than 2 inches) concrete may be placed by unobstructed free fall down the center of the shaft. In wet holes concrete shall be placed by tremie methods or by pumping in a manner acceptable to the Geotechnical Engineer's Representative.

3.5.6.2 Vibrate upper 20 feet of each drilled pier.

3.5.7.1 Place concrete in each drilled pier continuously without interruption.

3.5.7.2 Protect top of drilled pier from entry of soil or foreign matter during concrete placement and until concrete has set.

3.5.10.1 Cure top and all formed concrete surfaces per Section 033000 - Cast-in-Place Concrete.

3.5.11 Form the top of drilled piers as necessary wherever grade is below scheduled top of drilled pier at time of concrete placement.

3.9 Field Quality Control and Assurance

3.9.1 Drilled piers shall be installed under the full-time monitoring of the Geotechnical Engineer's Representative. Provide facilities required to assist in the inspection and testing of excavations. Cooperate with inspecting and testing personnel to expedite the work.

3.9.2 Owner will select and pay an independent Testing Laboratory to secure and test cylinders, perform slump tests, and ensure compliance with Specifications. Contractor is required to arrange for all testing. Also refer to Section 033000 - Cast-in-Place Concrete.

3.9.3 Owner's Testing Agency will take one set of four 6 by 12 in. cylinders or one set of five 4 by 8 in. cylinders for each 150 cubic yards of concrete, or fraction thereof, placed in any one day. One cylinder will be tested in compression at 7 days and two 6 by 12 in. cylinders or three 4 by 8 in. cylinders will be tested at 28 days in accordance with ASTM C 39. One cylinder will be kept in reserve for additional testing if required.

3.9.4 Owner's Testing Agency may take core samples of in-place concrete when inspections or test results are such that there is reasonable doubt about the quality of concrete or specified concrete strengths have not been attained.

1. Complete continuous coring of drilled piers may be required, at Drilled Pier Contractor's expense, where time of removal of temporary casings exceeds specified limits, or where observations of placement operations indicates cause for suspicion of quality of concrete, presence of voids, segregation or other possible defects.
2. Defective piers shall be corrected by the addition of piers and/or cap beams by the Contractor at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS ARE INCLUDED IN ARTICLE 1.8 ABOVE.

PART 3 - EXECUTION

3.1 EXECUTION REQUIREMENTS ARE INCLUDED IN ARTICLE 1.8 ABOVE.

END OF SECTION

SECTION 32 1123

CRUSHED STONE AND DENSE GRADED AGGREGATE (DGA)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install crushed stone aggregates and DGA as indicated on the Drawings and/or required in the Specifications for such uses as surfaces and/or bases of roads, parking areas and walkways; temporary and permanent traffic bound surfacing over trenches; permanent traffic bound roadway surface maintenance; replacement of unsuitable material; and other miscellaneous applications required in the work.

B. Various sizes, types and quality of crushed stone aggregates are specified in this Section depending on applicability which may be specified in detail in other sections of these Specifications.

C. The ENGINEER may require the use of crushed stone aggregates for purposes other than those specified in this or other Specification sections if such use is advisable in his opinion. Payment for crushed stone aggregate shall be by negotiation unless agreed pricing has been previously established.

1.02 RELATED WORK

A. Earthwork is included in Section 31 2000.

1.03 SUBMITTALS

A. Testing Service shall submit required test reports directly to the ENGINEER with copy to CONTRACTOR.

PART 2 PRODUCTS

2.01 MATERIALS

A. Crushed stone aggregate shall meet the applicable requirements for the intended use in accordance with Section 805 of the Kentucky Transportation Cabinet, Department of Highways, Standard Specifications for Road and Bridge Construction.

B. Unless otherwise referred to on the Drawings or in these Specifications, crushed stone aggregate shall be graded size No. 57 according to the table below.

C. When referred to on the Drawings or in these Specifications, dense graded aggregate (DGA) shall have a sand equivalent value of not less than 25 and shall be graded according to the table below.

D. Coarse aggregate gradations referred to by number size on the Drawings or in these Specifications shall conform to the following table (as copied from the above Kentucky Transportation Cabinet Specifications, Table 805.07):

TABLE I - SIZES OF COARSE AGGREGATES - KENTUCKY

Size	Max. Size Square Openings (1)	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS) PERCENTAGE BY WEIGHT																	
		100 (4)	90 (3 1/2)	75 (3)	63 (2 1/2)	50 (2)	37.5 (1-1/2)	25 (1)	19 (3/4)	12.5 (1/2)	9.5 (3/8)	4.75 (No. 4)	2.36 (No. 8)	2 (No. 10)	1.18 (No. 16)	600 (3) (No. 30)	425 (3) (No. 40)	150(3) (No. 100)	75 (3) (No. 200)
1	90 (3 1/2)	100	90-100		25-60		0-15		0-5										
2	63 (2 1/2)			100	90-100	35-70	0-15		0-5										
23	63 (2 1/2)			100		40-90		0-15		0-5									
3	50 (2)				100	90-100	35-70	0-15		0-5									
357	50 (2)				100	95-100		35-70		10-30		0-5							
4	37.5 (1-1/2)					100	90-100	20-55	0-15		0-5								
467	37.5 (1-1/2)					100	95-100		35-70		10-30	0-5							
5	25 (1)						100	90-100	20-55	0-10	0-5								
57	25 (1)						100	95-100		25-60		0-10	0-5						
610	25 (1)						100	85-100		40-75		15-40							
67	19 (3/4)							100	90-100		20-55	0-10	0-5						
68	19 (3/4)							100	90-100		30-65	5-25	0-10		0-5				
710	19 (3/4)							100	80-100		30-75	0-30							
78	12.5 (1/2)								100	90-100	40-75	5-25	0-10		0-5				
8	9.5 (3/8)									100	85-100	10-30	0-10		0-5				
9-M	9.5 (3/8)									100	75-100	0-25	0-5						
10	4.75 (No. 4)										100	85-100						10-30	
11	4.75 (No. 4)										100	40-90	10-40					0-5	
DGA(2)	19 (3/4)							100	70-100		50-80	30-65				10-40			2-10
GRAVEL BASE(2)	37.5 (1-1/2)					100						25-65					6-30	5-20	
CSB(2)	50 (2)				100		90-100		60-95		30-70	15-55				5-20			0-8

(1) Nominal size in mm (inches), unless otherwise shown (2) Gradation performed by wet sieve KM 64-420 (3) micrometers

E. Testing

1. Unless otherwise required in this Section, the ENGINEER shall determine the tests required for crushed stone aggregates according to Section 805. The CONTRACTOR shall be responsible, initially, and periodically at no cost to the OWNER, to deliver materials proposed for use or being used in the work to a testing laboratory selected by the OWNER. This provision shall apply to any other aggregate tests required in this Section.

2. The OWNER shall be responsible to pay the laboratory testing costs. However, once a material has been tested and accepted for use, the CONTRACTOR shall be responsible throughout the job to use materials which are equal in all respects and from the same source as that accepted material delivered to the testing laboratory.

3. The CONTRACTOR shall pay for additional tests ordered by the ENGINEER after acceptance of tested materials when such tests show the quality of materials has become deficient or when the CONTRACTOR requests a change of material supplier and/or source.

PART 3 EXECUTION

3.01 INSTALLATION

A. Compacted Crushed Stone Aggregate

1. Crushed stone shall be placed in uniform layers not greater than 6 inches deep and shaped by power equipment to required lines, grades, cross sections, and depths. No minimum compacted density, method of compaction, or compaction equipment is required since a nominal amount of compaction effort with vibration can establish the desired intergranular locking of the aggregate under controlled placement depth. Acceptable compaction can be achieved with pneumatic-tired and tracked equipment and rollers.

2. All compaction operations shall be performed to the satisfaction of the ENGINEER.

3. Crushed stone shall be placed in those areas as shown on the Drawings and as may be directed by the ENGINEER.

B. Compacted Dense Graded Aggregate (DGA)

1. Dense graded aggregate shall be plant mixed with water, transported in such a manner as to deliver the mix to the project without loss or segregation, spread, and compacted to produce a density throughout not less than 84 percent of solid volume. Minimum dry density for compacted limestone DGA shall be 139 pounds per cubic foot when S.G. of limestone is 2.65.

2. Density tests shall be required in such number as determined by the ENGINEER. Density tests shall be made by the sand cone method or by nuclear gauges. The CONTRACTOR shall furnish all necessary labor, equipment, and materials for making the density tests under observations of the ENGINEER.

3. In the event compacted material does not meet the required density of an area, the CONTRACTOR shall either continue compaction efforts or rework the entire area until the required density is obtained. If material has to be removed and reworked, the ENGINEER shall determine if removed material can be remixed and used again for fill.

4. All compacted DGA fill shall be included in the CONTRACTOR'S lump sum bid unless otherwise indicated on the Drawings.

END OF SECTION

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SECTION 321162 – CRUSHED STONE 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. Granular Crushed Stone Paving

B. Related Sections:
   1. Division 32 Section ‘Metal Edging’
   2. Division 32 Section ‘Soil Preparation and Mixes’
   3. Division 32 Section 'Turf and Grasses’
   4. Division 32 Section 'Exterior Planting’
   5. Division 32 Section ‘Unit Paving’

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) Relevant standards (most current specification or standards applies) include but are not limited to the following:
   1. ASTM D-2940 Standard Specification for Graded Aggregate Material for Bases or Sub-bases for Highways or Airports
   2. ASTM 136-93 Method for Sieve Analysis of Fine and Coarse Aggregates
   3. ASTM C-33

1.4 ACTION SUBMITTALS

A. Product Data for the following: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Approval by the Landscape Architect of submitted product data or other submittals does not constitute final acceptance.
   2. For Base Course, submit Material Certification and Analysis Report. Refer to and comply with requirements specified in Division 31 “Earthwork” as applicable.
   3. For Crushed Stone, submit Material Certification and Analysis Report, indicating compliance with Specifications.
   4. Submit product literature or tear sheets giving name of product, manufacturer's name and compliance with Specifications.

B. Samples for Initial Selection: Submit, prior to installation of Crushed Stone Selection Mock-ups, samples to indicate aggregate and mix proportions for each type. Resubmit to confirm product selections after Selection Mock-up completion.

C. Samples for Verification:

1. Granular Crushed Stone material component each type and/or color: In quantity equal to two (2) pounds. Samples shall be the basis for selection of single colors or color mixtures for Field Samples/Mock-ups.
2. Separation Geotextile: Submit two (2) 12 inch x 12 inch squares.

D. Field Samples / Mockups: Construct at the earliest possible time and at approved location, before proceeding with Work and after Landscape Architect's approval of submitted samples. Submit proposed locations for field samples / mockups and receive approval of locations prior to construction of field samples. Provide and construct sample panel of Crushed Stone paving as specified to show appearance, workmanship, and finish of work, complete and in coordination with work of other Sections as applicable.
1. For Crushed Stone Work: After final selection of Crushed Stone material, provide and construct one (1) Crushed Stone paving surfacing sample, 3 feet by 3 feet, complete with base course and compacted Crushed Stone paving surface as specified in this Section.
   a. Coordinate sample work with conditions and material placement of other sample work or completed work for edging and adjacent conditions.
   b. Mock-up construction for Crushed Stone work will be utilized as a visual confirmation of proposed finish components in addition to establishing a standard for Project construction.

E. Work Field Sample/Mock-ups of Crushed Stone surfacing must be approved by the Landscape Architect before actual on-site paving work may proceed. If necessary, remove and reconstruct Field Sample/Mock-up surfacing until approved. Approved sample surfacing serves as standard of acceptance for final Crushed Stone paving work.

F. Demolish and remove Field Samples/Mock-ups at a time approved by the Landscape Architect and the Owner and when no longer required to serve for material selection or as a standard of work. Accepted mockup may be incorporated as part of Work if conforming to specified requirements, and if accepted by the Landscape Architect.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each kind of accessory, from manufacturer.
1. Submit for each manufactured item or treatment of this Section or required to complete Crushed Stone paving work. Include descriptive information, test reports, and other data of manufacturer.
   a. Submit product literature or tear sheets giving name of product, manufacturer's name and compliance with Specifications.
2. For Crushed Stone, submit Material Certification and Analysis Report.
3. Include instructions for handling, storage, installation and protection.

B. Qualification Data: For qualified installer. Include list of completed projects with project names and addresses, names and addresses of Landscape Architects and Owners, and other information specified.

1.6 QUALITY ASSURANCE

A. The work of this section shall be performed by a company which specializes in the type of paving work required for this project, with a minimum of ten (10) years of documented successful experience and shall be performed by skilled workmen thoroughly experiences in the necessary crafts.

B. Installer Qualifications: Installer shall have a minimum of five (5) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere, in the installation of crushed stone paving specified, and the products, systems, and scope specified. An experienced foreman with a minimum of ten (10) years of experience will oversee all work.

C. Source Limitations: Ensure that supplier has adequate supply of material to complete work without delay.

D. Product Testing
   1. Gradation of Crushed Stone materials according to ASTM C 136 “Method for Sieve Analysis for Fine and Course Aggregates.”

E. Pre-installation Meeting: Before beginning paving work, schedule and conduct a meeting at Project site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Contractor, the installer, the installer’s field foreman and manufacturer’s representative. Inform the Landscape Architect ten (10) business days in advance of the scheduled meeting time.

F. Field Engineering: All line and grade work not presently established at the site shall be laid out by a registered Lands Surveyor or Professional Civil Engineer employed by the contractor in accordance with the Contract document. Establish permanent benchmarks and maintain all established benchmarks, bound and replace any which are destroyed or disturbed.

1.7 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in clearly marked containers showing net weight, guaran-teed analysis and name of manufacturer. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration by moisture and temperature during delivery and during storage at site. Protect liquid components from freezing.

B. Time delivery of all Crushed Stone, so as to minimize on site storage time prior to installation. Protect all stored materials and items from weather, careless handling, and vandalism. Repair or replaces damaged items, as determined by the Landscape Architect.

C. Deliver, store, handle and protect aggregate and Crushed Stone material with provision for drainage and intrusion of dirt, debris, or other foreign matter.

D. Store Crushed Stone material under cover to prevent accumulation of moisture until placed.

1.9 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.

B. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.

C. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

D. Work Protection Requirements: Provide weather protection during entire time of placement of crushed stone system. Maintain protection over entire area storage and work area to maintain specified moisture levels, prevent wind or rain disturbance of setting materials, protect from run-off from adjacent areas, and generally maintain optimum installation conditions.
   1. Contractor is responsible for means and methods for such protection, including physical cover, work sequencing and scheduling and other means of protection, as Contractor deems appropriate.

E. Environmental Requirements: Verify all Environmental Requirements with manufacturer prior to commencing work.
   1. Prevent wind or rain disturbance of setting materials, protect from sheet flow from adjacent areas, and generally maintain optimum installation conditions.
   2. Do not install Crushed Stone paving in conditions of standing water. Surface and sub-drainage must be assured at all times.
   3. Cold-Weather Protection:
      a. Do not undertake work on frozen substrate or using frozen materials or materials mixed with or coated with ice or frost.
      b. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen sub-grade or setting beds.
      c. Temperature: Do not place Crushed Stone paving when the ambient temperature is below 40 degrees F., or when there is frost in the base course, or any other time when weather conditions are unsuitable for the type of material being placed.
      d. Remove and replace Crushed Stone paving work damaged by frost or freezing.

F. Layout and Grades:
   1. All lines not previously established at the site shall be laid out by a registered Land Surveyor or Professional Engineer employed by the Contractor in accordance with the Contract Documents.
   2. Coordinate surfacing layout with work of other sections.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate Work of this Section with Work of all other Sections of Specifications.

1.11 OPERATIONS AND MAINTENANCE DATA

A. Provide Maintenance and cleaning instructions for Owner.

B. Provide to Owner all product warranties provided by manufacturers.

1.12 EXTRA STOCK

A. Crushed Stone: Provide 150 lb. Total, bagged in minimum 25 lb. bags.

PART 2 - PRODUCTS

2.1 GRANULAR CRUSHED STONE SYSTEMS

A. Provide Crushed Stone washed and clean from dust, sand, organic and deleterious material. Crushed Stone material and mixes with approved color range to be as selected and reviewed by Landscape Architect using mock-ups for Crushed Stone paving selection.

B. Subject to compliance with requirements, provide Standard Pathway Mix as available from Kafka Granite, 550 East Highway 153, Mosinee, WI 54455; Telephone: 715-256-8153.
1. Color: To be selected from Supplier's full range.
2. Crushed Stone Grading: Material shall consist of sound, angular, durable particles:

Sieve Size	Percent Passing by Weight
No. 4	80-100
No. 8	65-90
No. 16	40-65
No. 30	25-55
No. 50	15-35
No. 100	10-20
No. 200	5-15

2.2 GEOTEXTILE

A. Product will meet, at a minimum, the following physical requirements, and shall be 140N as manufactured by Mirafi, Inc. or Approved Equal:
1. Grab Strength (ASTM D1682): 180 pounds, min.
2. Puncture Strength (ASTM D3787): 80 pounds, min.
3. Burst Strength (ASTM D3786): 290 psi, min.
4. Trapezoid Tear (ASTM D1117): 50 pounds, min.
5. Equivalent Opening Size (COE CW 02215): Soil with 50 percent or less particles by weight passing U.S. No. 200 sieve, AOS less than 0.6 mm (greater than U.S. No. 30 sieve).
6. UV Resistance (ASTM D4355): 70 percent strength retained for all classes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify the conditions, elevations, and measurements affecting the work of this Section prior to installation. Examine surfaces to receive stonework and do not proceed until any defects detrimental to the finished work are corrected.

B. Notify the Landscape Architect in writing of conditions detrimental to proper completion of Work.

C. Do not begin Crushed Stone paving work until unsatisfactory conditions have been corrected and substrate is ready to receive paving.

D. Examine the subgrades in areas designated to receive Crushed Stone paving system for correct compaction, grade, and pitch as a base for paving system installation.

E. Proof roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction. Compact subgrade under paving systems to a minimum 95% modified Proctor density.
   1. Contractor shall have compaction tests taken and reported at questionable areas as directed by Landscape Architect.

F. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.2 PREPARATION

A. Geotextile Installation:
   1. Install as shown in Drawings. Where necessary, fabric will be lap jointed a minimum of 12 inches in a straight line. Fabric will be held tight until setting bed material has been placed and compacted.

B. Crushed Stone Surfacing Installation
   1. Compaction: Compact Crushed Stone paving surface in a minimum of two (2) operations. Compact until surface elevations are within tolerances specified herein and to a uniform density within range of 90 to 92 percent at optimum moisture content. Hand tamp near edges of adjoining material to avoid damage to adjoining curbs, lawns, edge materials, and other work.
      a. First Compaction Operation: While the Crushed Stone mix is still thoroughly moist, roll with a heavy lawn type roller (minimum 225 pounds and maximum 30 inch width), to achieve finish grade and initial compaction. Hand tamp at edges as specified.
      b. Second Compaction Operation: Use a heavy (1 ton minimum) small rider equipment type, after having initially used the lawn roller, to obtain the desired final dense, smooth, uniform texture.
      c. Do not use whackers or vibratory rollers.

C. Tolerances for Crushed Stone Paving
   1. The final paving surface level shall not deviate from the design levels by more than plus or minus 3/16 inch, when measured under a 10-foot long steel or aluminum straightedge.

2. The Crushed Stone surface with adjacent pavements shall not show any difference in level. All humps or depressions exceeding the specified tolerance shall be corrected at no additional cost to the Owner.

3.3 INSPECTION AND ADJUSTMENT

A. Finished Crushed Stone surface shall be smooth, uniform and solid, with no evidence of chipping or cracking.

B. Any significant irregularities shall be smoothed out prior to final acceptance of work. Smoothing shall be accomplished by rewetting/saturating rough areas thoroughly, and then rolling the surface again with a heavy roller.

3.4 CLEANUP

A. Prevent materials used for installing the work of this Section from staining or damaging the exposed surfaces of adjoining construction. Immediately remove Crushed Stone other detrimental materials from exposed sur-faces of stone or adjoining construction.

B. After installation, protect paving from damage or deterioration during subsequent construction activities, and until time of Substantial Completion.

C. All materials generated by construction activities during this phase of work shall be completely removed at the end of this phase and the site shall be left in a safe and clean condition.

D. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day’s work. Burning of material or dumping on the site is prohibited.

E. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly condition, "broom clean".

END OF SECTION 321162

SECTION 321170 – SALVAGED BOULDERS

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. Installation of reclaimed salvaged boulders on site.

B. Related Sections:
   1. Division 03 Section ‘Cast in Place Concrete’
   2. Division 03 Section ‘Miscellaneous Site Concrete’
   3. Division 32 Section ‘Unit Paving’
   4. Division 32 Section 'Soil Preparation and Mixes’
   5. Division 32 Section 'Exterior Planting’

1.3 ACTION SUBMITTALS

A. Product Data: Submit an inventory list and high resolution color photographs and text descriptions of each reclaimed boulder to show the full range of size, shape, color, texture, and finishes for the boulders that are expected for the Work.

B. Stockpile Plan: Submit a stockpiling plan to be followed by the Contractor during construction and by the Owner during the Warranty Period, including provisions, such as temporary planking, to protect boulders from occasional heavy loads.

C. Boulder Selection: The Landscape Architect will select all boulders on site. The Contractor or his representative shall be present for selection of boulders on site. The Contractor shall make all pre-selection arrangements on site to ensure a ready supply of materials, equipment and manpower required for an efficient selection procedure. Request the site visit at least fourteen (14) days in advance of the desired selection date.
   1. Boulders shall be individually chosen and tagged by the Landscape Architect. The contractor shall provide dimensions of selected boulders to the Landscape Architect for determination of placement.

D. Mockups: Build mockups to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Build mockups for a typical installed salvaged boulder. Include a minimum of three full size salvaged boulders installed on site for review.
   2. Protect accepted mockups from the elements with weather-resistant membrane.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification for:
   1. Installer

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: The work of this section shall be performed by companies which specialize in the installation of stone and rockwork required for this Project, certified in writing with pictures of similar work, with a minimum of five years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.

B. Pre-installation Meeting: Before beginning boulder work, schedule and conduct a meeting at the site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Architect, the Landscape Architect, Owner's Representative, Contactor, the installer, and the installer's foreman. Inform the Landscape Architect fourteen (14) business days in advance of the scheduled meeting time.

1.6 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affection transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.7 PROJECT CONDITIONS

A. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk and expense.

B. Layout and Grades:
   1. All lines not previously established at the site shall be laid out by a registered Land Surveyor or Professional Engineer employed by the Contractor in accordance with the Contract Documents.
   2. Coordinate surfacing layout with work of other sections.

PART 2 - PRODUCTS

2.1 SALVAGED BOULDERS

A. Materials salvaged from the site during excavation for re-installation in locations as indicated in the Drawings. Boulders shall be selected by the Landscape Contractor from the following materials:
   1. Naturally occurring and weathered rocks uncovered during the excavation of the site.

B. Salvaged materials are to be set aside for review and selection for re-installation by the Landscape Architect.
   1. Sort salvaged materials by size and condition.
   2. Salvaged boulders are to be saw-cut as needed to remove broken edges. Any boulders less than 24” x 24” in size will not be accepted.
      a. Salvaged boulders that are determined to be too small, defective, or damaged shall be properly disposed of off-site.
   3. Store materials for re-installation that are sound and free from defects impairing strength, durability or appearance, such as cracks and seams.
   4. Boulders shall be cleaned prior to placing into storage. Remove all residual aggregate base material and dirt.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspection: Verify the conditions, elevations, and measurements affecting the work of this Section prior to installation. Examine surfaces to receive stonework and do not proceed until any defects detrimental to the finished work are corrected. Notify the General Contractor in writing of conditions detrimental to proper completion of Work. Starting work means acceptance of existing conditions.

B. Verify all measurements and dimensions and coordinate the installation of this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, site drainage, and other work or adjoining construction.

3.2 INSTALLATION OF SALVAGED BOULDERS

A. Place all rocks in a stable condition with a minimum of three contact surfaces.

B. Place boulders in the field in accordance with approved layout for verification by the Landscape Architect before setting in aggregate base. Boulders shall be individually placed in consultation with the Landscape Architect on site.

C. After the Landscape Architect’s verification of the positions of the boulders, set bottom of each boulder as indicated in Drawings.

3.3 CLEAN UP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day's work. Burning of material of dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly condition, "broom clean".

END OF SECTION 321170

SECTION 321216 - ASPHALT PAVING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide asphaltic concrete paving as shown and specified. The work includes:

1. Cut and removal of existing asphalt pavement.
2. Final subgrade preparation and paving base.
3. Milling of existing asphalt pavement.
4. Hot-mix asphalt pavement patching.
5. Hot-mix asphalt pavement.
6. Hot-mix asphalt pavement overlay.
7. Pavement thermoplastic and paint striping and markings.

1.02 QUALITY ASSURANCE

A. Testing and inspection: Performed by a qualified independent testing laboratory.

B. Contractor shall provide and pay for testing and inspection during paving operations. Laboratory and inspection service shall be acceptable to the Civil Engineer.

C. Materials and methods of construction shall comply with the following standards:

1. Kentucky Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

2. American Society for Testing and Materials, (ASTM).

3. American Association of State Highway and Transportation Officials, (AASHTO).

4. Asphalt Institute, (AI).

5. National Crushed Stone Association, (NCSA).

D. Provide material furnished by a bulk asphaltic concrete producer regularly engaged in the production of hot-mix, hot-laid asphaltic concrete paving materials.

E Tolerances:

1. In-place compacted thickness:

a. Base course: Maximum 1/2" plus, minus 0".

b. Surface course: Maximum 1/4" plus, minus 0".

2. Finished surface smoothness:

a. Base course: Maximum 3/8" in 10'-0".

b. Surface course: Maximum 1/4" in 10'-0", any direction.

1.03 SUBMITTALS

A. Product data:

1. Submit complete materials list of items proposed for the work. Identify materials source.

2. Submit asphalt mix design and pavement striping paint product data.

B. Submit reports for testing and inspection of the following:

1. Subgrade surfaces.

2. Base materials.

3. Surface materials.

4. Compaction operations.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver manufactured products in manufacturer's original, unopened, and undamaged containers with labels intact and legible.

B. Store and handle manufactured products to prevent damage and deterioration.

1.05 PROJECT CONDITIONS

A. Weather limitations:

1. Do not install base course materials over wet or frozen subgrade surfaces.

2. Do not apply prime and tack coat materials when temperature is 60 degrees F. or below. Do not apply to wet base surface.

3. Install asphalt base course materials only when air temperature is 40 degrees F. or above and rising at time of placement.

4. Install asphalt surface materials only when base is dry and air temperature is 60 degrees F. or above and rising at time of placement.

5. Apply pavement striping and marking paint only on clean, dry pavement and only when surface temperature is at least 55 degrees F. and not exceeding 95 degrees F. at time of application.

B. Grade control: Establish and maintain the required lines and grades, including crown, inverted crown, and cross-slopes, for each course during paving operations.

C. Provide temporary barricades and warning lights as required for protection of project work and public safety.

D. Protect adjacent work from damage, soiling, and staining during paving operations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Subgrade fill: Inert subsoil material free of organic matter, rubbish, debris, and rocks greater than 4" diameter.

B. Aggregate base: Dense Grade Aggregate (DGA). Comply with Section 805 of the Kentucky Department of Highways Standard Specifications for Road and Bridge Construction.

C. Tack coat: Comply with Section 806 of the KYDOH Standard Specifications for Highway and Bridge Construction.

D. Asphaltic base course: Superpave mixture comforming to AASHTO MP2. CL. 2 1.0D PG 64-22 complying with the KYDOH Standard Specifications for Highway and Bridge Construction.

E. Asphaltic surface course: Superpave mixture comforming to AASHTO MP2. CL. 3 0.38D PG 64-22 complying with the KYDOH Standard Specifications for Highway and Bridge Construction.

F. Joint filler: ASTM D 6690 or AASHTO M 324, commercial grade, hot applied, single-component, polymer-modified bituminous joint filler.

G. Asphalt Sealant: ASTM P 2939 Commercial Grade, asphalt emulsion sealant.

H. Pavement-Marking Paint for parking spaces: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type F; color: as indicated on drawings. Color to match adjacent existing markings.

I. Thermoplastic Extruded Thermoplastic Pavement Markings: Product shall meet KYTC Section 837, consisting of maleic-modified glycerol ester resin (alkyd binder) to formulate the thermoplastic material. Ensure the pigment, pre-mix beads, and filler are uniformly dispersed in the resin.

2.02 EQUIPMENT

A. Paving equipment: Spreading, self-propelled asphalt paving machines capable of maintaining line, grade, and thickness shown.

B. Compacting equipment: Self-propelled rollers, minimum 10 ton weight.

C. Hand tools: Rakes, shovels, tampers, and other miscellaneous equipment required to complete the work.

D. Pavement marking equipment: Provide spray machines specifically designed for pavement marking.

PART 3 EXECUTION

3.01 INSPECTION

A. Cut and remove existing asphalt pavement designated on the plans. Examine subgrades and installation conditions. Do not start asphaltic concrete paving work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Proof roll the subgrade and do all necessary rolling and compacting to obtain firm, even subgrade surface. Fill and consolidate depressed areas. Remove uncompactible materials, replace with clean fill, and compact to 95% of the maximum dry density in accordance with ASTM D698 Standard Proctor Method.

B. Frame adjustments:

1. Verify frames for manholes, catch basins, and other such units, within areas to be paved, are at their proper elevation.

2. Adjust frames as required to match paving. Provide temporary closures over openings until completion of rolling operations. Remove closures at completion of the work. Set covers to grade, flush with the surface of adjoining pavement surface.

C. Coordinate junction of new and existing pavement. Saw cut existing pavement to provide a uniform straight line transition. Meet existing surface levels and maintain drainage slopes. Feathering of transitions is not acceptable.

D. Cold Milling: Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to minimum depth of 1-1/2” or as indicated on plans.
2. Mill to a uniform finished surface free of excessive gouges, grooves and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

D. Apply tack coat to contact surfaces of existing pavement, curbs, and structures abutting pavement.

3.03 INSTALLATION: GENERAL

A. Comply with Asphaltic Institute (AI) MS-3 Asphalt Plant Manual for material storage, control and mixing, and for plant equipment and operation.

B. Transport asphaltic concrete mixtures from the mixing plant to the project site in trucks with tight, clean compartments.

C. Pavement replacement:

1. Remove and waste existing asphaltic concrete pavement surface and unsuitable base materials off site.

2. Obtain inspection, testing and approval of subgrade surfaces by Geotechnical Engineer prior to installing fill or paving base materials.

3. Disc, dry, and recompact or undercut soft and wet subgrade soils prior to placement of any engineered fill. Excavate unsatisfactory soil materials extending below subgrade elevation to depth as directed by the Geotechnical

Engineer. Extra excavating and placement of additional fill will be paid for as a change in work. Obtain Civil Engineer's written authorization before performing extra excavation work.

4. Place engineered fill in layers not to exceed 8" in loose thickness with each layer compacted to 95% of the maximum dry density in accordance with ASTM D698 Standard Proctor Method or as specified by the Soils Engineer.

5. Exercise care during earthwork operations to provide adequate surface drainage of all silty-clay soils. Absorption of heavy rainfall, accumulations of water, and heavy construction traffic may result in softening silty-clay soils, and severely weakening subgrade soils shear strength. Failure to consider forecast of wet weather, protect subgrade from moisture or provide adequate drainage will negate Contractor’s claims for extra excavation.

6. Install geogrid as indicated on the plans per manufacturer’s recommendations.

7. Install DGA base material.

8. Install leveling and surface courses flush with existing adjacent pavement.

D. Repairs:

1. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of ¼ inch

a. Clean cracks and joints in existing hot-mix asphalt pavement. Use commercial grade, hot-applied joint filler to fill cracks and joints. Fill flush with surface of existing pavement and remove excess filler.

2. Asphalt emulsion sealant: Clean surface of dirt after crack filler has cured. Mix sealant per manufacturer’s recommendations. Apply single coat by brush or two coats by sprayer. Allow to dry for 48 hours prior to opening to traffic.

3.04 INSTALLATION: BASE MATERIALS

A. Install aggregate base materials up to 6" thickness in single course; install 6" and greater thickness in 2 equal courses, base course and top course, total compacted depth as scheduled.

B. Compact aggregate base materials to 84% of the solid volume density as determined by Kentucky Method 64-607 until a uniformly-smooth, hard surface, complying with the lines, grades, elevations, and cross-sections shown has been established. Moisture may be added at job site to aid compaction.

C. Asphaltic base may be used as a wearing surface during construction operations. If used, base shall be inspected and approved by the Geotechnical Engineer, damaged portions removed and replaced, and the entire surface thoroughly cleaned before application of tack coat and finish wearing surface.

3.05 INSTALLATION: SURFACE MATERIALS

A. Remove loose and foreign material from compacted aggregate base immediately before application of asphaltic materials. Do not start surface work until all other work which may damage the finish surface is completed.

B. Install asphaltic base course in multiple courses up to 2” in depth per course, as necessary to provide the total compacted depth as scheduled. Spread at minimum 250 degrees F.

C. When asphalt surface material is not installed immediately following the asphaltic base course installation, apply tack coat on base course, following acceptance by Civil Engineer, at the rate of 0.05 to 0.15 gallons per sq. yd. Allow to dry and cure as required.

D. Place, spread, and strike off the asphalt concrete mixture on a properly prepared and conditioned surface. Inaccessible and small areas may be placed by hand. Place each course to the required grade, cross-section, and scheduled compacted thickness.

E. Place materials in strips not less than 10'-0" wide. After the first strip has been placed and rolled, place all succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course materials.

F. Carefully make joints between old and new pavements, and between successive day's work, to ensure a continuous bond between adjoining work. Construct joints to have the same texture, density, and smoothness as other sections of the asphalt concrete course.

G. Apply tack coat to contact surfaces of existing pavement, curbs, and structures abutting pavement.

H. Begin rolling operations when the asphalt concrete mixture will bear the weight of the roller without excessive displacement. Compact areas inaccessible to rollers with vibrating plate compactors.

I. Perform breakdown, second and finish rolling until the asphalt concrete mixture has been compacted to the required surface density and smoothness. Required average density shall be 96% of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94% nor greater than 100%. Continue rolling until all roller marks are eliminated. Provide a smooth compacted surface true to thickness and elevations required.

J. After final rolling, do not permit vehicular traffic on the pavement until it has cooled and hardened, and in no case sooner than 8 hours.

K. Protect newly placed material from traffic by barricades or other suitable methods acceptable to the Civil Engineer.

3.06 PAVEMENT SURFACE STRIPING AND MARKING

A. Do not apply pavement-marking paint until layout and placement have been verified with Civil Engineer.

B. Allow pavement to cure for two (2) days prior to beginning pavement markings.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply thermoplastic pavement markings with heat per the manufacturer's instructions.

E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.07 FIELD QUALITY CONTROL

A. Provide field quality control testing and inspection during asphaltic concrete paving operations.

B. Contractor shall provide adequate notice, cooperate with, provide access to the work, obtain samples, and assist Test Agency and their representatives in execution of their function.

C. Before constructing base course, field verify subgrade surfaces are adequate and meet or exceed design bearing values. Provide testing for each type of paving required.

D. When requested, perform laboratory tests on asphalt pavement mixes to determine compliance with specified requirements.

E. Perform 1 series of compaction tests for aggregate base for each course for each day's work.

F. When requested, test in-place asphalt base course and surface courses for compliance with density and thickness. Take not less than 4" diameter pavement specimens of each completed course. Repair test specimen holes to match adjacent work.

1. Average density of in-place material: Equal to or greater than 96%, with no individual determination less than 94% or greater than 100% of average density of laboratory specimens.

2. Perform 1 test for density for each course for each day's work.

3. Thickness: Make 1 test (minimum) for each 5,000 sq. ft. of each type of paving.

G. Test for surface smoothness with 10'-0" straight-edge. Deficient areas shall be defined, removed, and replaced, or adjusted to design thickness by methods acceptable to the Civil Engineer.

H. When, during progress of work, field tests indicate that installed compacted materials do not meet specified requirements, remove defective material, install new materials, and retest at Contractor's expense, as directed by the Civil Engineer.

3.08 PROTECTION

A. Protect paving from damage due to construction and vehicular traffic until final acceptance.

3.09 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from paving operations.

B. Sweep pavement and wash free of stains, discolorations, dirt, and other foreign material immediately prior to final acceptance.

END OF SECTION 321216

SECTION 321313 - CONCRETE 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. This Section includes exterior cement concrete pavement for the following:
   1. Standard Broom Finish Sidewalks.
   2. Turned Down Slabs.
   3. Curb & Gutters.
   4. Heavy Duty Pavement.
   5. Slabs beneath pavers.
   6. Historic Mix Sidewalks.

B. Related Sections include the following:
   1. Section 312000 "Earth Moving" for subgrade preparation, grading, and subbase course.
   2. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
   3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

E. 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 of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
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.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

D. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

E. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, portland cement Type II

a. Fly Ash: ASTM C 618, Class C.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Historic Concrete Mix
1. Pea Gravel
2. Class A Sand
3. Fly Ash

D. Water: Potable and complying with ASTM C 94/C 94M.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: 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. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Curing compounds: Sodium silicate type. No dissipating resins are permitted.

1. Products:

a. Chem-Rex Mastertop CST
b. L & M Construction Chemicals – L & M Cure
c. Sonneborn - Sonosil

2.5 CONCRETE CLEANER

A. General purpose acidic cleaner to be used to remove construction dirt or mortar from brick or concrete without burning or streaking.
1. Sure Klean 600 by Prosoco or approved equal.

2.6 WATER REPELLENT

High-performance, penetrating water repellent for concrete. Chem-trete 40 VOC by Protectosil - Evonik Degussa Corporation, 800-828-0919 or approved equal.

2.7 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ChemMasters; Exposee.
b. Conspec by Dayton Superior; Delay S.
c. Dayton Superior Corporation; Sure Etch (J-73).
d. Edoco by Dayton Superior; True Etch Surface Retarder.
e. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
f. Kaufman Products, Inc.; Expose.
g. Meadows, W. R., Inc.; TOP-STOP.
h. Metalcrete Industries; Surftard.
i. Nox-Crete Products Group; CRETE-NOX TA.
j. Scofield, L. M. Company; LITHOTEX Top Surface Retarder.
k. Sika Corporation, Inc.; Rugasol-S.
l. SpecChem, LLC; Spec Etch.
m. TK Products, Division of Sierra Corporation; TK-6000 Concrete Surface Retarder.
n. Unitex; TOP-ETCH Surface Retarder.
o. Vexcon Chemicals Inc.; Certi-Vex Envioset.
p. Perk Products; Black Bull Surface Sol for Historic Mix

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4500 psi
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45
3. Slump Limit: 4 inches (100 mm)

C. Cementitious Materials: Use fly ash, pozzolan, as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.

D. Standard Concrete Mix: Used for curb/gutter, sidewalks in the right-of-way, dumpster & transformer pad, slabs beneath pavers and other designated sidewalks and pads. Mix uses standard angular crushed limestone aggregate.

E. Historic Concrete Mix: Mix design shall be as follows:

Quantity	Material
470 lbs	Type 1 Portland cement
100 lbs	Fly Ash
2340 lbs	Class A Sand
850 lbs	Pea Gravel
35 gallon	Water
5 oz	Water Reducer
1 oz	Air Entrainment

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Division 31 Section "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet (15.25 m)unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement or side forms.

Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Standard Medium Textured Broom Finish: Provide a medium finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic. Match adjacent existing concrete sidewalk finish.

3.8 SPECIAL FINISHES

A. Historic Concrete Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is too small or inaccessible to power units.

Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Finish concrete with a very light wash to expose a small amount of aggregate.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.

7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft. (465 sq. m) or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Concrete paving will be considered defective if it does not pass tests and inspections.

I. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

J. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 321320 – LANDSCAPE CONCRETE FINISHES

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. Special finish concrete paving

B. Related Sections:
   1. Division 03 Section ‘Cast in Place Concrete’
   2. Division 32 Section ‘Concrete Paving Joint Sealants’
   3. Division 32 Section 'Concrete Paving’

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
   1. Ten (10)-lb sample of integral aggregate for special finish concrete paving.

E. Other Action Submittals:
   1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

F. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, sources of supply, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Landscape Architect and approved in writing.

G. Material Certificates: For the following, from manufacturer:
1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

H. Coordinate submittals with joint sealant submittals of Division 07 Section “Sitework Joint Sealants”.

I. Minutes of pre-installation conference.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Field quality-control reports.

1.6 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of local, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials.

C. Procure and pay for permits and licenses required for Work.

1.7 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 / C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Installer Qualifications:
1. An experienced installer who has completed concrete Work 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. Installer is to have a minimum of ten (10) years of experience with concrete Work similar to that indicated for this Project.

2. Installer shall demonstrate successful experience with installing exposed/seeded aggregate special finish concrete paving by citing five (5) successful installations in climates that experience seasonal freeze-thaw cycles. At least one project shall by min. 3000 sf. For each project include the following:
   a. Project Description
3. Project location.
4. Date of installation
5. Completed project photos

C. Measurements and Allowable Tolerances: Conform to requirements of referenced standards but provide more restrictive tolerances where required to meet job conditions.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated.

E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

F. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated. Comply with the following, unless more stringent provisions are required by governmental authorities having jurisdiction:

G. Mockups: Build mockups at the earliest possible time, at approved location per Landscape Architect, to verify selections made under sample submittals and to demonstrate aesthetic effects and standard for workmanship.
1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; sur-face finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Landscape Architect and not less than 96 inches by 96 inch-es.
   a. Install mockup with sample of adjacent curb and including special features, such as expansion joints and paver trays for utility surface expressions. Coordinate with material requirements as specified in other sections.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
4. Notify Landscape Architect seven (7) days in advance of dates and times when mockups will be constructed.

H. Samples: Prior to mockup, construct special finish concrete paving samples showing an assortment of seeding rates and aggregate sizes. Each sample shall be 12-inch x 12-inch. Samples will be re-quired until design intent is achieved, and approval is given by Landscape Architect. Only after a sample has been approved shall the contractor commence mockup construction. Samples shall match the approved mockup.

I. Preinstallation Conference: Conduct conference at Project site.
1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.

c. Ready-mix concrete producer.
d. Concrete pavement subcontractor.
e. Landscape Architect
f. Construction Manager
g. Architect

1.8 PROJECT CONDITIONS

A. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk and expense.

B. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

C. Do NOT dispose of excess concrete and water-borne debris from cleaning out equipment in adjacent areas designated to be future planting beds.

1.9 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packages materials n clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration during delivery and during storage at site.

B. Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. Comply with requirements outlined in Division 32 Section “Concrete Paving”.

2.2 SITE CONCRETE PAVING MATERIALS

A. For nonvehicular areas, including concrete walk and ramps, refer to Division 32 Section “Concrete Paving” for cementitious materials, mixture design, steel reinforcement, and reinforcement accessories.

2.3 SPECIAL FINISH CONCRETE MIX

A. Cementitious Materials: Refer to Division 32 Section “Concrete Paving”. Use cementitious materials, of same type, brand, and source throughout Project:
1. Cement: Portland Cement, Type I, ASTM C 150

B. Integral (Normal Weight) Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
   1. Light Aggregate Type: #8 Gravel
      a. Manufacturer: Chaney Enterprises, 2410 Evergreen Rd Suite 201, Gambrills, MD 21054
      b. Phone: (301) 932-5000

C. Seeded Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
   1. Aggregate Coverage Rate: 95-100%
   2. Dark Aggregate Type: Northern Black Basalt, 1/4-inch x 1/8-inch.
      a. Manufacturer: Fister Quarries, 1150 Lyon Road, Batavia, IL 60510
      b. Phone: (630) 761-0100
      c. Website: www.fisterquarries.com

D. Aggregate Ratios, per sq ft:
      a. Light Aggregate: 0.86 pounds per square foot
      b. Dark Aggregate: 0.39 pounds per square foot.

E. Water: Potable and complying with ASTM C 94 / C 94M.

F. Location: As indicated in Drawings (Concrete Paving - Pedestrian - Type B).

G. Admixtures: Refer to Division 32 Section “Concrete Paving”.

2.4 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber.
   1. Refer to Division 07 Section “Sitework Joint Sealants”.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect exposed surfaces including flat work as required to prevent damage by impact or stains.

3.2 FINISHES, GENERAL

A. General:
   1. Match Landscape Architect’s design reference sample, identified and described as indicated, to the satisfaction of Landscape Architect.
   2. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

B. Flatwork:
   1. Unless otherwise noted or specified, finish slabs monolithically. Take special care that a smooth, even joint is obtained between successive pours.

3.3 SPECIAL FINISHING

A. Seeded Exposed-Aggregate Finish:
   1. Immediately after initial floating, spread a single layer of Dark Aggregate uniformly on paving surface.
   2. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16-inch.
   3. Lightly power-wash paving surface.
   4. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
   5. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.

3.4 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.5 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
   1. Elevation: 1/8 inch
   2. Thickness: Plus 3/8 inch, minus 1/4 inch.
   3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/8 inch.
   4. Joint Spacing: 1/4 inches.
   5. Contraction Joint Depth: Plus 1/4 inch, no minus.
   6. Joint Width: Plus 1/8 inch, no minus.

3.6 DEFECTIVE WORK

A. Defective Work: The following will be deemed as defective work:
   1. Finish which is not true to line and plane.
   2. Finish which is not in conformance with specified finish and appearance requirements.
   3. Finish which exceeds specified tolerances.
   4. Work which does not properly connect to adjoining work.

3.7 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Landscape Architect.

B. Drill test cores, where directed by Landscape Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing sur-face stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.8 CLEANUP

A. Do NOT dispose of excess concrete and water-borne debris from cleaning out equipment in adjacent areas designated to be future planting beds.

B. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store mate-rial at the end of each day’s work. Burning of material or dumping on the site is prohibited.

C. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly condition, "broom clean".

END OF SECTION 321320

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

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. Expansion and contraction joints within cement concrete pavement.

B. Related Sections include the following:

1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. Qualification Data: For Installer.

E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the commencement of the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 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.
2. When joint substrates are wet or covered with frost.
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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, 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. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component Polyurethane Sealant for Concrete: Single-component, non-priming, self-leveling, gun-grade elastomeric polyurethane sealant complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.

1. Available Products:

1) Sonneborn, Sonolastic SL 1.

PART 3 - EXECUTION

3.1 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.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on 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.

3.3 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 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 provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

D. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified 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 sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

F. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 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 and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 321410 – 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. Precast concrete pavers on slab-on-grade.
   2. Precast concrete pavers on pedestal supports.

B. Related Sections:
   1. Division 32 Section ‘Concrete Paving’
   2. Division 32 Section 'Joint Sealants’
   3. Division 32 Section 'Soil Preparation and Mixes’
   4. Division 32 Section 'Turf and Grasses’
   5. Division 32 Section 'Exterior Planting’
   6. Division 32 Section ‘Metal Edging’
   7. Division 32 Section ‘Salvaged Boulders’

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

   1. Submit product literature or tear sheets giving name of product, manufacturer's name and compliance with Specifications.
   2. For unit paving varieties proposed for use on Project, include test data indicating compliance with physical properties required by referenced ASTM standards.

B. Sieve Analyses: For aggregate setting-bed materials and sand for joints, according to ASTM C 136.

A. Shop Drawings: Submit for fabrication and installation of paving. Submit large scale dimensioned cutting and setting drawings depicting sections and profiles of the paving units, actual dimensions and tolerances, arrangement and provision for jointing, expansion joints (if required), position of anchors and other necessary details for the work. Include all adjacent conditions (utility items and existing top of structure) and field verified conditions and dimensions. Indicate location on the setting drawings with a number system corresponding to number marked on each unit.

   1. Shop drawings to be drafted by qualified draftsman.
      a. Include evidence of experience including project list.

   2. Show location layouts and patterns, including Points of Beginning, coordinated with the design drawing and related survey control points and dimensions.

3. Establish and verify dimensions with work of on-site structures and elements, layouts and patterns of other work, and other like conditions.
4. Show connections for drain frames and grates, and all other site improvements.
5. Show location of soft caulked joints.
6. Show location, type and extent of anticipated field cutting.
7. Show location, type and extent of anticipated oversized pavers.
8. Do not clean or prepare any unit paving (except for samples) until Shop Drawings have been approved for fabrication by Landscape Architect.

B. Samples for Initial Selection: Submit samples of material for joints and accessories involving color selection.

C. Samples for Verification:

1. For each unit paver type and finish indicated. Include at least five (5) samples in each set for each type of unit paver, to be not less than 12 inches by 12 inches, exhibiting extremes of the full range of color and other visual characteristics expected in completed Work.
2. Joint filler materials.

D. Field Samples / Mockups: Construct at the earliest possible time and at approved location, before proceeding with Work and after Architect's approval of submitted samples. Submit proposed locations for field samples / mockups and receive approval of locations prior to construction of field samples. Provide and construct sample of each type of work as specified herein to show appearance, workmanship, and finish of work, complete and in coordination with work of other Sections as applicable (i.e. walls, curbs, stairs, other paving types and sitework sealants).
1. Build mock-ups for each type and finish of unit paving in sizes approximately 96 IN long by 96 IN wide by full thickness.
   a. Include a sealant-filled joint at least 16 inches long in each mockup.
2. Coordinate mock-ups with required mock-ups of other Specification sections.
3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and aesthetic qualities of workmanship.
   a. Approval of mockups is also for other material and construction qualities Landscape Architect specifically approves in writing.
   b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
5. The field sample/mockup must be approved by the Architect before the actual paving work may proceed. If necessary, remove and reconstruct field sample until approved. Accepted mockup establishes minimum standard of quality and workmanship for paving work of this Section.
6. Demolish and remove field samples at a time approved by the Architect when no longer required to serve as a standard of work. Mock-up may be incorporated as part of Work if conforming to specified requirements, and if accepted by the Landscape Architect and the Owner.

E. Guarantee: The Contractor shall obtain in Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

F. Maintenance Program: Submit a maintenance and cleaning program to be followed by the Contractor during construction and by the Owner during Warranty Period.

1.4 INFORMATIONAL SUBMITTALS

A. Submit Qualification Data for:
   1. Draftsman for Shop Drawings- Include evidence of experience including project list.
   2. Fabricator - Include evidence of experience including project list.
   3. Installer - Include evidence of experience including project list.
   4. Testing agencies - Include evidence of experience including project list.
   5. Firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Test Reports: Submit certified reports by an approved testing agency. Make submittals at least three (3) weeks prior to delivery of materials to site. Include data on all properties specified for the respective materials. Reports shall be representative of the current manufacturing of fabrication process and shall be no older than six (6) months.
   1. Joint filler materials.

C. Certificates/Manufacturer’s Data: Submit for approval of Architects sources of supply and manufacturer's specifications, quality control, product data, and test reports for the following: Include instructions for handling, storage, installation and protection.
   1. Cleaning agent

1.5 QUALITY ASSURANCE

A. The work of this section shall be performed by a company which specializes in the type of paving work required for this project, with a minimum of ten (10) years of documented successful experience and shall be performed by skilled workmen thoroughly experiences in the necessary crafts.

B. Fabrication Qualifications: Fabrications shall be by a firm or firms who have successfully fabricated unit paving of each material type and condition, similar to the quality specified, and in the quantity shown for a period of not less than ten (10) years.
   1. Fabricator shall submit qualifications to the Landscape Architect for his review.

C. Draftsman Qualifications: Shop Drawings shall be drafted by a single firm who have provided Shop Drawings successfully similar to the size and scope of this project and who have a minimum of ten (10) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere.
   1. Draftsman shall submit qualifications to the Landscape Architect for his review.

D. Installer Qualifications: Installer shall have a minimum of ten (10) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere, in the installation of paving work of the sizes and setting beds specified, and the products, systems, and scope specified.
   1. Installer shall submit qualifications to the Landscape Architect for his review.
   2. Installation Foreman: Installation firm for exterior paving and curbing of this Project shall have on staff a supervising Foreman assigned full time to this Project, from time of mock-up installations, who shall have at least twenty (20) years total unit paving installation experience and with at least ten (10) years of experience in installations of equivalent or more extensive type and scope to this Project. Submit detailed resume of past experience with dates, duration and scope identification, Project name and location, and work function of previous projects worked on.

3. Use members of skilled workmen equal to work requirement or occasion. The skilled workmen shall be thoroughly trained and experienced in the necessary crafts and shall be completely familiar with the specific requirements and methods needed for performance of the work in this Section.

E. Source Limitations: Obtain each type of unit paver, regardless of finish, from one manufacturer with resources to provide materials of consistent quality in appearance and physical properties.
1. Material Stock: Before start of fabrication, the Contractor shall certify to the Landscape Architect that there is a sufficient stock of appropriate unit pavers for completion of the Work within the Contract time schedule.
a. The Landscape Architect may, during the course of the work, visit the places of fabrication. The Contractor shall afford these representatives free access and cooperation in the performance of their duties.

F. Source Limitations for Other Materials: Obtain each type of joint material and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

G. Mock-ups: Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Pre-installation Meeting: Before beginning paving work, schedule and conduct a meeting at Project site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Contractor, the installer, the installer's field foreman and manufacturer's representative. Inform the Landscape Architect five (5) business days in advance of the scheduled meeting time.

I. Field Engineering: All line and grade work not presently established at the site shall be laid out by a registered Lands Surveyor or Professional Civil Engineer employed by the contractor in accordance with the Contract document. Establish permanent benchmarks and maintain all established benchmarks, bound and replace any which are destroyed or disturbed.

J. Maintenance Program: Submit a maintenance and cleaning program to be followed by the Contractor during construction and by the Owner during Warranty Period, including provisions, such as temporary planking, to protect pavement from occasional heavy loads.

1.6 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling: Properly crate and band paving units for shipment and receiving at job site. Handle each paving material type to prevent chipping, marking, breakage, soiling, or other damage both during delivery and during storage at site.
   1. Pavers shall be delivered and unloaded at job site. Care shall be taken to prevent damage to the product during hauling and handling at the job site.
   2. Lift and support units only at designated lifting or supporting points shown on Shop Drawings.

B. Storage and Protection: Store paving units on non-staining wood skids or pallets set not less than four (4) inches above ground, covered with non-staining, waterproof membrane. Place and stack skids and pavers to distribute weight evenly and to prevent breakage or cracking of pavers. If units are not stored in an enclosed location, protect stored unit pavers from weather with waterproof cover to prevent staining or contamination but allow air to circulate around units.

C. Packaged Materials: Deliver packaged materials in clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration by moisture and temperature during delivery and during storage at site. Protect liquid components from freezing.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

E. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

F. Store liquids in tightly closed containers protected from freezing.

1.8 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.

B. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.

C. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

D. Work Protection Requirements - Provide weather protection during entire time of placement of paving system. Maintain protection over entire area storage and work area to maintain specified moisture levels, prevent wind or rain disturbance of setting materials, protect from run-off from adjacent areas, and generally maintain optimum installation conditions. Contractor is responsible for means and methods for such protection, including physical cover, work sequencing and scheduling and other means of protection, as Contractor deems appropriate.

1. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen sub-grade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

E. Environmental Requirements:
   1. Verify all Environmental Requirements with manufacturer prior to commencing work.
   2. Weather/Temperature: (Cold Weather Requirements) Do not commence work when a descending air temperature in the shade away from artificial heat reaches 40 deg F, and do not resume until an ascending air temperature in the shade and away from artificial heat reaches 35 deg F.
      a. Do not undertake work on frozen substrate or using frozen materials or materials mixed with or coated with ice or frost.
      b. Protect work from frost and remove and replace any work damaged by frost or freezing.
      c. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
      d. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
   3. Weather/Temperature: (Hot Weather Requirements) Protect paving work when temperature and humidity conditions produce excessive evaporation of setting beds. Provide artificial shade and windbreaks and use cooled materials as required.
      a. Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.9 UTILIZATION RESTRICTIONS

A. Plywood panels must be kept on areas which will be subject to continued movement of materials and equipment.

B. Maintenance of Traffic, Access and Utilities: In accordance with Division 01.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate Work of this Section with Work of all other Sections of Specification.

B. Proceed with paving setting work only after curbs, steps, drains, and other projections through substrate have been installed and when substrate construction and framing of openings have been completed.

1.11 CLOSEOUT REQUIREMENTS

A. Project Record Documents: Submit in accordance with Division 01 Section “Project Record Documents”.

B. Final Cleaning: In accordance with Division 01 Section “Cleaning”
   1. Remove all excess joint filler from the paver surface and leave site in an orderly, “broom clean” condition.

1.12 OPERATIONS AND MAINTENANCE DATA, WARRANTIES

A. Provide Maintenance and cleaning instructions for Owner.

B. Provide to Owner all product warranties provided by manufacturers.

1.13 EXTRA STOCK AND SPARE PARTS

A. Concrete Unit Pavers: Provide one (1) pallet or twenty-five (25) paving units of each size and finish.

PART 2 - PRODUCTS

2.1 GRAVEL BASE

A. Gravel base material shall conform to Division 31 “Earthwork”.

2.2 CONCRETE SUB-SLAB

A. Concrete base shall conform to Division 32 Section “Concrete Paving”.

2.3 PAVERS, GENERAL

A. Paving units shall be the best quality material from a single manufacturer.

B. Exposed surfaces and edges of paving units will be free from cracks, broken corners, chipped edges, scratches, or other defects affecting appearance. No patching or hiding of defects will be permitted.

C. Paving units having flaws or imperfections are not acceptable and will be rejected and will be replaced with approved unit pavers at Supplier's expense.

D. Paving units shall be uniformly consistent in color value, graining texture and other features to the extent inherent in each type.

E. Color and value variations shall be within ranges established by approved samples.

2.4 CONCRETE UNIT PAVERS

A. Subject to compliance with requirements, provide Hanover Prest Paver and Traditional Prest Bricks by Hanover Architectural Products, Inc., 5000 Hanover Road, Hanover, PA 17331; Telephone: 717-637-0500; Website: www.hanoverpavers.com
   1. Type 1
      a. Size: 11 3/4” x 23 1/2”
      b. Oversize Paver Size: 11 3/4” x 35 3/8” or 17 5/8” x 23 1/2"
      c. Thickness: 3 inches
      d. Color: Natural
      e. Finish: Tudor

2. Type 2
   a. Size: 11 3/4” x 23 1/2”
   b. Oversize Paver Size: 11 3/4” x 35 3/8” or 17 5/8” x 23 1/2”
   c. Thickness: 3 inches
   d. Color: Limestone Gray
   e. Finish: Tudor
3. Type 3
   a. Size: 11 3/4” x 23 1/2”
   b. Oversize Paver Size: 11 3/4” x 35 3/8” or 17 5/8” x 23 1/2”
   c. Thickness: 3 inches
   d. Color: Charcoal
   e. Finish: Tudor
4. Type 4
   a. Size: 23 1/2” x 47 1/8”
   b. Oversize Paver Size: N/A
   c. Thickness: 2-1/2 inches
   d. Color: Limestone Gray
   e. Finish: Tudor
5. Type 5
   a. Size: 5 7/8” x11 3/4”
   b. Oversize Paver Size: 11 3/4” x 11 3/4” or 5 7/8” x 17 5/8”
   c. Thickness: 3 inches
   d. Color: Limestone Gray
   e. Finish: Tudor
6. Type 6
   a. Size: 5 7/8” x11 3/4”
   b. Oversize Paver Size: 11 3/4” x 11 3/4” or 5 7/8” x 17 5/8”
   c. Thickness: 3 inches
   d. Color: Charcoal
   e. Finish: Tudor

2.5 BITUMINOUS SETTING BED MATERIALS FOR CONCRETE UNIT PAVERS

A. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver Manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3

C. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20

D. Neoprene-Modified Asphalt Adhesive: Paving Manufacturer’s standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

2.6 BITUMINOUS SETTING BED MIX FOR CONCRETE UNIT PAVERS

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F.

2.7 JOINT MATERIALS FOR CONCRETE UNIT PAVERS

A. Sand for Joints shall conform to the following gradation in accordance with C-144-84 and shall be a combination of manufactured sand and natural sand:

1.

Sieve Size	Percent Finer by Weight
No. 4	100
No. 8	95-100
No. 16	70-100
No. 30	40-75
No. 50	20-40
No. 100	10-25
No. 200	0-10

% Fracture, by Weight, Minimum: 75
Sand Equivalent, Minimum: 40

2. The fracture requirement shall be at least two mechanically fractured faces and will apply to material retained on each sieve size No. 50 and above.
3. Provide sand of color needed to produce required joint color.

B. Organic Joint Sand Stabilizer: For unit paver installations where sand filled joints are indicated, use mixture of joint sand and stabilizer additive.
1. Base Product: Pave Tech, Prior Lake MN (800-728-3832, www.pavetech.com); SandLock Additive.
2. Comply with manufacturer's written instructions for mixing, applying, activating and protecting stabilized sand joint filling mixture.

2.8 PAVER PEDESTAL SUPPORTS

A. Subject to compliance with requirements, provide Hanover Elevator Pedestal System as manufactured by Hanover Architectural Products, Inc., 5000 Hanover Road, Hanover, PA 17331; Telephone: 717-637-0500; website: www.hanoverpavers.com; the components used shall be:
1. Base
2. Top Plate
3. Coupler
4. StayBar
5. Flexible Leveling Shims
6. Compensator Leveling System
7. Perimeter Spacer

B. Provide 3/8" thick galvanized steel plate to hold small cut pieces of pavers against walls/curbs, by bridging over several adjacent pedestals. Plate shall bear on at least 2 pedestals in each direction from cantilevered portion of plate in order to support small cut pieces of pavers.

C. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

2.9 PREPARATION

A. Gravel sub-base material, concrete sub-slab, and concrete stair footing shall be compacted and placed in accordance with Division 31 ‘Earthwork’, Division 32 Section “Concrete Paving”, and Division 3 Section “Cast in Place Concrete”.

B. Wash and sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Clean paver units prior to setting to remove soil, stains, and foreign materials that could impair bonding, bedding, or appearance. Do not use wire brushes or implements that will mark or damage exposed surfaces. If it is necessary to use cleaning compounds, use only those that are mild or contain no caustic or harsh filler or abrasives.

2.10 INSTALLATION, GENERAL

A. Do not use pavers units with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers units from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut paver units with motor-driven masonry saw equipment to provide clean, sharp, un-chipped edges. Cut units to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting or use of a block splitter is not acceptable.

D. Joint Pattern: As indicated on Drawings.

E. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced, and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
   1. Provide joint filler at waterproofing that is turned up on vertical surfaces, unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.

F. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8-inch in 24 inches and 1/4-inch in 10 inches from level, or indicated slope, for finished surface of paving.

G. Expansion and Control Joints: Provide joint filler and sealant at locations and of widths indicated. Install joint filler before setting pavers.

H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

I. Pavers abutting light fixtures, building faces, utility surface expressions or vertical elements are to fit around these objects with a maximum of 1/8-inch joint.

2.11 MORTAR SETTING-BED MATERIALS

A. Regional Materials: Provide aggregate, cement, and lime for mortar that has been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Portland Cement: ASTM C 150, Type I or Type II.

C. Hydrated Lime: ASTM C 207, Type S.

D. Sand: ASTM C 144.

E. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

F. Water: Potable.

G. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062 inch in diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M except for minimum wire size.

2.12 MORTAR MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.

D. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 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. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: Running bond as indicated.

F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.

G. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

H. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in specification section 321373.

I. Provide edge restraints as indicated by drawings. Install edge restraints before placing unit pavers.

3.4 BITUMINOUS SETTING BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 degrees F. Strike setting bed smooth, firm, even, and not less than 3/4-inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.
   1. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16-inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

3.5 CONCRETE UNIT PAVER INSTALLATION ON SLAB-ON-GRADE

A. Unit paver installation shall be plumb, level and true to line and grade and shall coincide and align with adjacent work and elevations. Care shall be taken during the layout to minimize cutting.
   1. Paving of each area will proceed from one side or end; installation will not commence from opposite ends or sides.

B. Starting at paver layout baselines, commence laying the pavers on the undisturbed setting bed in the pattern and color as shown on the Drawings. Hand tamp with rubber mallet to ensure that each paver is in place, completely supported and at final finished grade. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
   1. Pavers shall be installed with hand-tight joints. String lines shall be used frequently to hold pattern lines true and accurate.
   2. Full units shall be laid first, and cuts done subsequently.
   3. Pavers abutting gutters, building faces, utility surface expressions or vertical elements to fit around these objects with a maximum of 1/8 inch joint.
   4. Cut pavers are to be no smaller than six (6) inches in any dimension on pedestrian areas. Where field cutting would result in pavers below these minimum sizes, use larger pavers adjacent to fill space. All units are to fit together accurately, with joint widths as indicated on Drawings.
   5. Installers shall lay subsequent pavers by moving forward on the top of the previously installed units.

C. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll

paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

D. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

E. Completion: The completed paver surface shall be cleaned and washed down. The final surface level will not deviate from the design levels by more than plus or minus 1/16-inch. The surface level of the pavers immediately adjacent to drainage outlets, gutters, and channels will not deviate by more than 3/16-inch. The final surface, when measured under a 10-inch-long steel or aluminum straightedge, will not vary by more than 1/4-inch. The surface of the adjacent pavers will not show any difference in level. All humps or depressions exceeding the specified tolerance shall be corrected at no additional cost to the Owner.

3.6 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch.

E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

G. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch-thick bond coat to mortar bed or to back of each paver with a flat trowel.

H. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

3.7 CONCRETE UNIT PAVER INSTALLATION ON ELEVATOR PEDESTAL SYSTEM

A. Inspect to ensure all substrates have been properly prepared to accept the pedestals. Any surface defect which may impair performance of the pedestals or waterproofing membrane shall be appropriately repaired. Commencement of work shall imply acceptance of surfaces.

B. Assure that the surface to accept the pedestals is clean and free of debris which would impair the performance of the pedestal system. Insulation and/or protection board must be applied over the water-proofing substrate. If specified, drainage mat, insulation and/or protection board must be installed according to manufacturer's recommendations. If protection is specified only under the pedestal, then each pad must extend beyond the edge of the pedestal base by a minimum of one (1) inch.

C. Grid Layout and Elevations
1. Level Installation: Once a starting point and the finished elevation of the paving surface has been determined, the support system elevation (finished elevation less the paver thickness) is established and marked around the perimeter using a transit, water level or laser leveling device.
2. Measurements are to be taken and two (2) perpendicular chalk lines "snapped" on the surface to receive the pedestals. Use these lines as a reference to check the paver layout during installation and to assure a square layout. Install pavers one row at a time.
3. At the starting row of pavers, a pedestal must be placed where each grid line meets the perimeter. Remove two spacer tabs in line with one another from atop each pedestal located along the perimeter. Adjust each to the elevation marked on the perimeter.
4. Position the pedestal as close to the edge of the perimeter as possible, with the two remaining spacer tabs aligned with the grid line. Using the elevation marked on the perimeter, stretch a ma-son's line along and slightly ahead of the second row of pedestals. A laser leveling device may also be used for this purpose.
5. Place pedestals in position prior to the paver installation. As pedestals along the grid lines are loaded, and prior to installing the next row of pavers, make fine vertical adjustment by rotating the base, or bottom of the pedestal. Clockwise rotation of the base will raise the bearing surface, and thus the paver(s). Counterclockwise rotation will lower the bearing surface.
6. If "quality control" slots at the base of the screw cylinder become visible, they indicate that the pedestal is extended beyond the minimum engagement of threads. The next larger size pedestal or a pedestal coupling unit must be used.
7. Slight irregularities in paver thickness can be compensated for by using one or more of four pie-cut segments of the New Leveling Shims which is placed under a paver corner(s) atop the pedestal bearing head.

D. If compensation for slope in the substrate surface is necessary or required, it may be accomplished in one of two ways:
1. New Leveling Shims rubber pads may be used in multiples, whole or segmented, and placed over the Elevator Pedestal System as shims to level the Elevator Pedestals.
2. Compensator Leveling System, base leveler disks may be used under the Elevator Pedestal System base to compensate for up to 1 inch per foot of slope. By placing the disk's thickest edge (where a small finger tab is located at the outer edge) at the downslope side of the pedestal, one disk compensates for 1/4 inch per foot slope. Using two or more disks, rotate in relation to one another to create a level pedestal placement.

E. Placement of Pavers and Final Adjustment
1. Pavers may be placed per the paver manufacturer's written instructions. Use of a stone lifter or other labor-saving device is acceptable. The base of the pedestal support may be rotated for slight adjustment when two pavers are already on the bearing head. Pavers should be leveled in each succeeding row.

F. Field Quality Control
1. Inspect often during installation to assure that grid (spacer) lines are straight and consistent, and that pavers are level. Where necessary, install rubber shims to eliminate the "rocking" of pavers. Unless otherwise specified to allow for expansion, pavers spacing at perimeter walls should not exceed 1/8 of an inch.

3.8 ADJUSTING AND REPAIRING

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.

3.9 WASTE DISPOSAL

A. Do not dispose of excess materials and water-borne debris from cleaning out equipment in adjacent areas designated to be future planting beds.

3.10 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day's work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 321410

SECTION 321600 – METAL 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:
   1. Aluminum edge restraints.

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 32 Section ‘Crushed Stone Paving’
   3. Division 32 Section ‘Concrete Paving’
   4. Division 32 Section 'Unit Paving’

1.3 SUSTAINABLE DESIGN SUBMITTALS

A. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.4 ACTION SUBMITTALS

A. Product Data for the following: For each type of product indicated.
   1. Submit product literature or tear sheets giving name of product, manufacturer's name and compliance with Specifications.

B. Shop Drawings: Submit for fabrication and installation of paving. Submit large scale dimensioned cutting and setting drawings depicting layout of edging with actual dimensions and tolerances, arrangement and provision for jointing, position of anchors and other necessary details for the work. Include all adjacent conditions (utility items and existing top of structure) and field verified conditions and dimensions.
   1. Shop drawings to be drafted by qualified draftsman.
   2. Include evidence of experience including project list.
   3. Show location layouts, including Points of Beginning, coordinated with the design drawing and related survey control points and dimensions.
   4. Establish and verify dimensions with work of on-site structures and elements, layouts and patterns of other work, and other like conditions.
   5. Do not fabricate any edging (except for samples) until Shop Drawings have been approved for fabrication by Landscape Architect.

C. Samples for Verification: For edging materials and accessories, with specified finishes; 24 inches long for each type of edging, with one anchoring device of each type.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data for:
   1. Draftsman for Shop Drawings- Include evidence of experience including project list.
   2. Fabricator - Include evidence of experience including project list.
   3. Installer - Include evidence of experience including project list.
   4. Firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Product Certificates: For each kind of edge restraint and accessory, from manufacturer.

C. Guarantee: The Contractor shall obtain in Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

1.6 QUALITY ASSURANCE

A. The work of this section shall be performed by a company which specializes in the type of work required for this Project, with a minimum of ten (10) years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.

B. Draftsman Qualifications: Shop Drawings shall be drafted by a single firm who have provided Shop Drawings successfully similar to the size and scope of this project and who have a minimum of ten (10) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere.
   1. Draftsman shall submit qualifications to the Landscape Architect for his review.

C. Fabrication Qualifications: Fabrications shall be by a firm or firms who have successfully fabricated metal edging of each material type and condition, similar to the quality specified, and in the quantity shown for a period of not less than ten (10) years.
   1. Fabricator shall submit qualifications to the Landscape Architect for his review.

D. Installer Qualifications: Installer shall have a minimum of ten (10) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere, in the installation of stonework of the sizes and setting beds specified, and the products, systems, and scope specified.
   1. Installer shall submit qualifications to the Landscape Architect for his review.
   2. Installation Foreman: Installation firm for metal edging of this Project shall have on staff a supervising Foreman assigned full time to this Project, from time of mock-up installations, who shall have at least twenty (20) years total installation experience and with at least ten (10) years of experience in installations of equivalent or more extensive type and scope to this Project. Submit detailed resume of past experience with dates, duration and scope identification, Project name and location, and work function of previous projects worked on.
   3. Use members of skilled workmen equal to work requirement or occasion. The skilled workmen shall be thoroughly trained and experienced in the necessary crafts and shall be completely familiar with the specific requirements and methods needed for performance of the work in this Section.

E. Source Limitations for Materials: Obtain each type of accessory and other materials from a single manufacturer for each product.

F. Pre-installation Meeting: Before beginning paving work, schedule and conduct a meeting at Project site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Contractor, the installer, the installer's field foreman and manufacturer's representative. Inform the Landscape Architect five (5) business days in advance of the scheduled meeting time.

G. Field Engineering: All line and grade work not presently established at the site shall be laid out by a registered Lands Surveyor or Professional civil Engineer employed by the contractor in accordance with the Contract Documents. Establish permanent benchmarks and maintain all established benchmarks, bound and replace any which are destroyed or disturbed

H. Maintenance Program: Submit a maintenance and cleaning program to be followed by the Contractor during construction and by the Owner during Warranty Period, including provisions, such as temporary planking, to protect pavement from occasional heavy loads.

1.7 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling: Properly crate and band metal edging for shipment and receiving at job site. Handle each edging to prevent corrosion, marking, bending, or other damage both during delivery and during storage at site.

B. Lift and support units only at designated lifting or supporting points shown on Shop Drawings.

C. Storage and Protection: Store stone units on non-staining wood skids or pallets set not less than 4 IN above ground, covered with non-staining, waterproof membrane. Protect stored edging from weather with waterproof cover to prevent staining or contamination but allow air to circulate around units.

D. Packaged Materials: Deliver packaged materials in clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration by moisture and temperature during delivery and during storage at site. Protect liquid components from freezing.

1.9 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.

B. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.

C. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

D. Work Protection Requirements - Provide weather protection during entire time of placement of edging system. Maintain protection over entire area storage and work area to maintain specified moisture levels, prevent wind or rain disturbance of setting materials, protect from run-off from adjacent areas, and generally maintain optimum installation conditions. Contractor is responsible for means and methods for such protection, including physical cover, work sequencing and scheduling and other means of protection, as Contractor deems appropriate.

E. Environmental Requirements:
   1. Verify all Environmental Requirements with manufacturer prior to commencing work.
   2. Weather/Temperature: (Cold Weather Requirements) Do not commence work when a descending air temperature in the shade away from artificial heat reaches 40 deg F, and do not resume until an ascending air temperature in the shade and away from artificial heat reaches 35 deg F.
   3. Do not undertake work on frozen substrate or using frozen materials or materials mixed with or coated with ice or frost. Protect work from frost and remove and replace any work damaged by frost or freezing.
      a. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   4. Weather/Temperature: (Hot Weather Requirements) Protect edging work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required.
      a. Do not apply mortar to substrates with temperatures of 100 deg F and above.
      b. Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.10 UTILIZATION REQUIREMENTS

A. Plywood panels must be kept on areas which will be subject to continued movement of materials and equipment.

B. Maintenance of Traffic, Access and Utilities: In accordance with Division 01.

1.11 SEQUENCING AND SCHEDULING

A. Coordinate Work of this Section with Work of all other Sections of Specifications.

1.12 CLOSEOUT REQUIREMENTS

A. Project Record Documents: Submit in accordance with Division 01 Section “Project Record Documents”.

B. Final Cleaning: in accordance with Division 01 Section “Cleaning”
   1. Leave site in an orderly, “broom clean” condition.

1.13 OPERATIONS AND MAINTENANCE DATA

A. Provide Maintenance and cleaning instructions for Owner.

B. Provide to Owner all product warranties provided by manufacturers.

PART 2 - PRODUCTS

2.1 METAL EDGING AND ACCESSORIES

A. Metal Edge – Type 1 (L-Shaped): Subject to compliance with requirements, provide aluminum edge restraints as manufactured by Permaloc, 13505 Barry Street, Holland, MI 49424; Telephone: 1-800-356-9660.
   1. Product: AsphaltEdge, located and sized per Drawings.
   2. Finish: Mill Finish (Natural Aluminum)

B. Metal Edge – Type 2 (Straight): Subject to compliance with requirements, provide aluminum edge restraints as manufactured by Permaloc, 13505 Barry Street, Holland, MI 49424; Telephone: 1-800-356-9660.
   1. Product: CleanLineXL, located and sized per Drawings.
   2. Finish: Mill Finish (Natural Aluminum)

C. Metal Edge – Type 3
   1. See Division 32 Section ‘Garden Roof Assembly’.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify the conditions, elevations and measurements affecting the work of this Section prior to installation. Examine surfaces to receive edging and do not proceed until any defects detrimental to the finished work are corrected. Notify the General Contractor in writing of conditions detrimental to proper completions of Work. Starting work means acceptance of existing conditions.

B. L-Shaped “Angle” Edging installed on cast in place concrete slab:
   1. Verify that the finish slab elevations in the underlying concrete are constructed as specified, so that the edging can be installed to the design grade and within the specified setting bed tolerances.
   2. Where edging is to be installed over existing waterproofing, examine the condition of the waterproofing and protection board with General Contractor present, for prover protection

from paving operations. Do not proceed with installation unless existing waterproofing system and protection boards are intact and acceptable. If repair is required, do not proceed until repair work is complete.

C. Straight Edging installed adjacent to crushed stone paving:
   1. Install metal edge restraints prior to placing adjacent crushed stone paving.
   2. Metal edging shall be installed at the locations shown in the Drawings and as detailed in the Drawings.
   3. Anchor as detailed in the Drawings or per Manufacturer's instructions. At a minimum, provide anchors at 30 in. O.C. as required to secure and maintain layout as indicated on Drawings.

D. Examine areas to receive metal edging for compliance with requirements and conditions affecting installation and performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Coordinate the installation of this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, site drainage, and other work or adjoining construction.

3.2 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day's work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly condition, "broom clean".

END OF SECTION 321600

SECTION 323113 – 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 all labor, materials, equipment, and services necessary to complete the fabrication and installation of fences and gates on site as shown on the drawings and specified herein, including but not limited to, the following:
   1. Aluminum Picket Fences
   2. Gates: Swing

B. Related Sections:
   1. Division 03 Section ‘Cast in Place Concrete’
   2. Division 07 Section ‘Sitework Joint Sealants’
   3. Division 32 Section 'Soil Preparation and Mixes’
   4. Division 32 Section 'Exterior Planting’

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM E 895 - Specification for Permanent Metal Railing Systems and Rails for Buildings
   2. ASTM E 935 - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Building Systems
   3. ASTM E 894 - Test Methods for Anchorage of Permanent Metal Railing Systems and Rails for Building Systems

B. American Welding Society (AWS)
   1. AWS D1.1 - Structural Welding Code.

C. Steel Structures Painting Council
   1. SSPC-SP6 - Surface Preparation Specification No. 6: Commercial Blast Cleaning

D. AISC (Manual of Steel Construction)

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: fence and gate framework 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. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 6 feet (3.66 m) high, and post spacing not to exceed 8 feet
2. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
   a. Wind Loads: Shall meet local requirements
   b. Exposure Category: Shall meet local requirements
   c. Fence Height: 6 feet
   d. Material Group: Aluminum

C. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.6 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 fences and gates.
   1. Fence and gate posts, rails, and fittings.
   2. Reinforcements, and attachments.
   3. Accessories: None
   4. Gates and hardware.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Samples for Verification: Prepared on Samples of size indicated below:
   1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

E. Fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer, testing agency, factory-authorized service representative.

B. Product Certificates: For each type of fence and gate, from manufacturer.

C. Product Test Reports: For framing strength according to ASTM F 1043.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
   1. Polymer finishes.
   2. Gate hardware.
   3. Gate operator.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

D. Mockups: Build mockups to set quality standards for fabrication and installation.
   1. Include 8-foot length of fence and single and double gate.

E. Preinstallation Conference: Conduct conference at Project site.
   1. Review sequence of operation for each type of gate operator.
   2. Review coordination of interlocked equipment specified in this Section and elsewhere.
   3. Review required testing, inspecting, and certifying procedures.

1.10 PROJECT CONDITIONS

A. Field Measurements: 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.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fences and gates that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of gate operators and controls.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

B. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FENCE FRAMING

A. Aluminum Fence as manufactured by Sentinel Fence & Rail, 1527 NC Hwy 711 Lumberton, NC 28360; Telephone: 877-999-0089; Website: www.sentinelmfg.com
   1. Model: Industrial Grade Sierra
   2. Material: Extruded and fabricated Aluminum
   3. Color: To be selected by Landscape Architect
   4. Panel width: As Shown on the Drawings
   5. Panel Height: As Shown on the Drawings

2.2 GATE

A. Aluminum Double Gate as manufactured by Sentinel Fence & Rail, 1527 NC Hwy 711 Lumberton, NC 28360; Telephone: 877-999-0089; Website: www.sentinelmfg.com
   1. Model: Industrial Grade Sierra
   2. Material: Extruded and fabricated Aluminum
   3. Color: To be selected by Landscape Architect
   4. Panel width: As Shown on the Drawings
   5. Panel Height: As Shown on the Drawings

2.3 ACCESSORIES

A. Lockable Gate Latch as provided by Sentinel Fence & Rail, 1527 NC Hwy 711 Lumberton, NC 28360; Telephone: 877-999-0089; Website: www.sentinelmfg.com

B. Gate Hinges as provided by Sentinel Fence & Rail, 1527 NC Hwy 711 Lumberton, NC 28360; Telephone: 877-999-0089; Website: www.sentinelmfg.com

C. Gate Drop Pin as provided by Sentinel Fence & Rail, 1527 NC Hwy 711 Lumberton, NC 28360; Telephone: 877-999-0089; Website: www.sentinelmfg.com

2.4 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.
   1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:
   1. Top Rail Sleeves: Aluminum Alloy 6063 not less than 6 inches long.
   2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Aluminum Alloy 6063.

F. Tension Bars: Aluminum, length not less than 2 inches shorter than full height of fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Mill-finished aluminum rod and turnbuckle or other means of adjustment.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. 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. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.6 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   1. Material above Finished Grade: Aluminum.
   2. Material on or below Finished Grade: Copper.
   3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.
   1. Connectors for Below-Grade Use: Exothermic welded type.
   2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for[a verified survey of property lines and legal boundaries,] site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
   1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. 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 or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install fencing to comply with ASTM F 567 and more stringent requirements indicated.

B. Install fencing on established boundary lines inside property line.

3.4 FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete 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 to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
      b. Concealed Concrete: Top 2 inches below grade as indicated on Drawings to allow covering with surface material.
      c. Posts Set into Concrete in Sleeves: 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, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings.

D. Line Posts: Space line posts uniformly at 8'-0" o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
   1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
   1. As required by manufacturer

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Intermediate and Bottom Rails: Install and secure to posts with fittings.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to fabric, wrap wire around post a minimum of 180 degrees, and attach other end to fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. 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.

3.6 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet
a. Gates and Other Fence Openings: Ground fence on each side of opening.
1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.8 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. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, and limit switches.
1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware, gate operator, and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain fences and gates.

3.10 CLEANING, PROTECTION AND ADJUSTMENT

A. Cleaning and Protection: Protect all work from misuse or damage during construction period with temporary protective coverings approved by ornamental metalwork fabricator. Remove protective covering at the time of Substantial Completion. Work, which is scratched, etched or damaged, may not be accepted by the Landscape Architect, and shall be replaced with acceptable work or, as approved, repaired at no additional cost to Owner

3.11 CLEAN UP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day's work. Burning of material of dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly condition, "broom clean".

END OF SECTION 323113

SECTION 323223 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes single-depth segmental retaining walls with soil reinforcement.

B. Related Sections:

1. Division 31 Section "Earth Moving" for excavation for segmental retaining walls.

1.2 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. **Delegated Design**: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, licensed in the Commonwealth of Kentucky, using performance requirements and design criteria indicated.

C. Structural Performance: Engineering design shall be based on loads due to soil pressures resulting from grades indicated and be according to NCMA's "Design Manual for Segmental Retaining Walls."

D. Seismic Performance: Engineering design shall be based on loads and factors due to soil pressures resulting from grades indicated and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."

E. Seismic Stability. Seismic loading shall be evaluated in accordance with AASHTO Load and Resistance Factor Design (LRFD) methodology as referenced in paragraph 1.03, subparagraph C.1.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each color and texture of concrete unit required.

C. Delegated-Design Submittal: For segmental retaining walls 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. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and field quality-control reports for compliance of materials and construction with design.

1.5 INFORMATIONAL SUBMITTALS

A. Preconstruction test reports.

B. Field quality-control reports. Drainage Pipe

C. Geotextile

D. Geosynthetic Soil Reinforcement (if required by the retaining wall design). The contractor shall provide certified manufacturer test reports for the geosynthetic soil reinforcement material in the manufactured roll width specified. The test report shall list the individual roll numbers for which the certified material properties are valid.

E. Installer Qualification Data. At least 14 days prior to construction, the General Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the Retaining Wall Installation Contractor, per paragraph 1.07, subparagraph A of this section.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch (1.6 mm) from specified dimension.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Big Block Gravity Retaining Walls as licensed by Verti-block, 16120 S. Pony Express Road Bluffdale, UT 84065, Phone: 801-571-2028, www.verti-block.com. or comparable product such as Redi-rock XL or Reading Rock ReCon.
2. Color & texture: As selected from manufacturer’s standard colors and forms.

B. All units shall be wet-cast precast modular concrete retaining wall units that form the external fascia of a modular unit retaining wall system.

C. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years or the total time the manufacturer has been licensed, whichever is less.

D. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It

shall be an original production mix meeting the requirements of ASTM C94 and exhibit the following:

1. Minimum 28-day compressive strength of 5,000 psi as tested in accordance with ASTM C 140.
2. Shall be free of water soluble chlorides and chloride based accelerator admixtures.
3. 6% +/- 1½% air-entrainment in conformance ASTM C94.
4. Maximum slump of 5 inches +/- 1½ inches (125 mm +/- 40 mm) per ASTM C143 for conventional concrete mix designs.
5. Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 18 inches and 32 inches (450 mm and 800 mm) as tested in accordance with ASTM C1611.
6. Moisture absorption rate of 5 percent to ensure adequate freeze-thaw protection.

E. Each concrete block shall be cast in a single continuous pour without cold joints with a maximum tolerance of plus or minus 1/8” for each dimension.

F. All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall. PMB units to be used in exposed wall construction shall not exhibit chips or cracks in the exposed face or faces of the unit that are not otherwise permitted. Chips smaller than 1.5” (38 mm) in its largest dimension and cracks not wider than 0.012” (0.3 mm) and not longer than 25% of the nominal height of the PMB unit shall be permitted. PMB units with bug holes in the exposed architectural face smaller than 0.75” (19 mm) in its largest dimension shall be permitted. Bug holes, water marks, and color variation on non-architectural faces are acceptable. PMB units that exhibit cracks that are continuous through any solid element of the PMB unit shall not be incorporated in the work regardless of the width or length of the crack.

I. Substitutions. Technical information demonstrating conformance with the requirements of this specification for an alternative precast modular block retaining wall system must be submitted for preapproval at least 14 calendar days prior to the bid date. Acceptable alternative PMB retaining wall systems, otherwise found to be in conformance with this specification, shall be approved in writing by the owner 7 days prior to the bid date. The Owner’s Representative reserves the right to provide no response to submissions made out of the time requirements of this section or to submissions of block retaining wall systems that are determined to be unacceptable to the owner.

2.02 GEOGRID REINFORCEMENT

A. Geogrid reinforcement shall be a woven or knitted PVC coated geogrid manufactured from high-tenacity PET polyester fiber with an average molecular weight greater than 25,000 (M_n > 25,0000) and a carboxyl end group less than 30 (CEG < 30). The geogrid shall be furnished in prefabricated roll widths of certified tensile strength by the manufacturer. The prefabricated roll width of the geogrid shall be 12” (300 mm) +/- 1/2” (13 mm). No cutting of geogrid reinforcement down to the 12” (300 mm) roll width from a larger commercial roll width will be allowed under any circumstances.

B. The ultimate tensile strength (T_{ult}) of the geogrid reinforcement shall be measured in accordance with ASTM D6637.

C. Geogrid – Soil Friction Properties
1. Friction factor, F*, shall be equal to 2/3 Tan ϕ, where ϕ is the effective angle of internal friction of the reinforced fill soil.
2. Linear Scale Correction Factor, α, shall equal 0.8.

D. Long-Term Tensile Strength (T_{al}) of the geogrid reinforcement shall be calculated in accordance with Section 3.5.2 of FHWA-NHI-10-024 and as provided in this specification.
   1. The creep reduction factor (RF_{CR}) shall be determined in accordance with Appendix D of FHWA-NHI-10-025 for a minimum 75 year design life.
   2. Minimum installation damage reduction factor (RF_{ID}) shall be 1.25. The value of RF_{ID} shall be based upon documented full-scale tests in a soil that is comparable to the material proposed for use as reinforced backfill in accordance with ASTM D5818.
   3. Minimum durability reduction factor (RF_D) shall be 1.3 for a soil pH range of 3 to 9.

E. Connection between the PMB retaining wall unit and the geogrid reinforcement shall be determined from short-term testing per the requirements of FHWA NHI-10-025, Appendix B.4 for a minimum 75-year design life.

F. The minimum value of T_{al} for geogrid used in design of a reinforced precast modular block retaining wall shall be 2,000 lb/ft (29 kN/m) or greater.

G. The minimum length of geogrid reinforcement shall be the greater of the following:
   1. 0.7 times the wall design height, H.
   2. 6 feet (1.83 m).
   3. The length required by design to meet internal stability requirements, soil bearing pressure requirements and constructability requirements.

H. Constructability Requirements. Geogrid design embedment length shall be measured from the back of the precast modular block facing unit and shall be consistent for the entire height of a given retaining wall section.

I. Geogrid shall be positively connected to every precast modular block unit. Design coverage ratio, Rc, as calculated in accordance with AASHTO LRFD Bridge Design Specifications Figure 11.10.6.4.1-2 shall not exceed 0.50.

J. Preapproved Geogrid Reinforcement Products.
   1. Miragrid XT Geogrids as manufactured by TenCate Geosynthetics of Pendergrass, Georgia USA and distributed by Manufacturers of the Redi-Rock Retaining Wall System.

K. Substitutions. No substitutions of geogrid reinforcement products shall be allowed.

2.03 GEOTEXTILE

A. Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. Additionally, the nonwoven geotextile fabric shall be placed in the v-shaped joint between adjacent block units on the same course. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288.

B. Preapproved Nonwoven Geotextile Products
   1. Mirafi 140N
   2. Propex Geotex 451
   3. Skaps GT-142
   4. Thrace-Linq 140EX
   5. Carthage Mills FX-40HS
   6. Stratatex ST 142

2.04 DRAINAGE AGGREGATE AND WALL INFILL

A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASTM D422:

U.S. Standard Sieve Size	% Passing
1-½" (38 mm)	100
1" (25 mm)	95-100
½" (13 mm)	25-60
No. 4 (4.76 mm)	0-10
No. 8 (2.38 mm)	0-5

2.05 REINFORCED FILL

A. Material used as reinforced backfill material in the reinforced zone (if applicable) shall be a granular fill material meeting the requirements of USCS soil type GW, GP, SW or SP per ASTM D2487 or alternatively by AASHTO Group Classification A-1-a or A-3 per AASHTO M 145. The backfill shall exhibit a minimum effective internal angle of friction, ϕ = 34 degrees at a maximum 2% shear strain and meet the following particle-size distribution requirements per ASTM D422.

U.S. Standard Sieve Size	% Passing
3/4" (19 mm)	100
No. 4 (4.76 mm)	0-100
No. 40 (0.42 mm)	0-60
No. 100 (0.15 mm)	0-10
No. 200 (0.07 mm)	0-15

B. The reinforced backfill material shall be free of sod, peat, roots or other organic or deleterious matter including, but not limited to, ice, snow or frozen soils. Materials passing the No. 40 (0.42 mm) sieve shall have a liquid limit less than 25 and plasticity index less than 6 per ASTM D4318. Organic content in the backfill material shall be less than 1% per AASHTO T-267 and the pH of the backfill material shall be between 5 and 8.

C. Soundness. The reinforced backfill material shall exhibit a magnesium sulfate soundness loss of less than 30% after four (4) cycles, or sodium sulfate soundness loss of less than 15% after five (5) cycles as measured in accordance with AASHTO T-104.

D. Reinforced backfill shall not be comprised of crushed or recycled concrete, recycled asphalt, bottom ash, shale or any other material that may degrade, creep or experience a loss in shear strength or a change in pH over time.

2.06 LEVELING PAD

A. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the Retaining Wall Design Engineer.

B. Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in section 2.04 or a preapproved alternate material.

C. Concrete used for construction of an unreinforced concrete leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to

placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi (17.2 MPa).

2.07 DRAINAGE

A. Drainage Pipe
   1. Drainage collection pipe shall be a 4" (100 mm) diameter, 3-hole perforated, HDPE pipe with a minimum pipe stiffness of 22 psi (152 kPa) per ASTM D2412.
   2. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.

B. Preapproved Drainage Pipe Products
   1. ADS 3000 Triple Wall pipe as manufactured by Advanced Drainage Systems.

PART 3 - EXECUTION

3.01 GENERAL

A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer's requirements.

B. The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.

C. New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.

D. The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.

E. All work shall be inspected by the Inspection Engineer as directed by the Owner.

3.02 EXAMINATION

A. Prior to construction, the General Contractor, Grading Contractor, Retaining Wall Installation Contractor and Inspection Engineer shall examine the areas in which the retaining wall will be constructed to evaluate compliance with the requirements for installation tolerances, worker safety and any site conditions affecting performance of the completed structure. Installation shall proceed only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Fill Soil.
   1. The Inspection Engineer shall verify that reinforced backfill placed in the reinforced soil zone satisfies the criteria of this section.
   2. The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the Retaining Wall Design Engineer as shown on the construction drawings.

B. Excavation.
   1. The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The

Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.

2. Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the Retaining Wall Design Engineer and "Division 31, Section 31 20 00 – Earthmoving" of these project specifications.
3. Embankment excavations shall be bench cut as directed by the project Geotechnical Engineer and inspected by the Inspection Engineer for compliance.

C. Foundation Preparation.
1. Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed. Additional foundation soils found to be unsatisfactory beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits are consistent with the requirements of the project Geotechnical Engineer and that all soil fill material is properly compacted according project specifications. The Inspection Engineer shall document the volume of undercut and replacement.
2. Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.
   a. The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. The Inspection Engineer shall immediately stop work and notify the Owner if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.
   b. The Inspection Engineer shall verify that the foundation soil exhibits sufficient ultimate bearing capacity to satisfy the requirements indicated on the retaining wall construction shop drawings per paragraph 1.06 I of this section.

D. Leveling Pad.
1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions shown on the retaining wall construction drawings and extend to the limits indicated.
2. Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 6" (150 mm). The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 lb (8.9 kN) of centrifugal force and to the satisfaction of the Inspection Engineer.
3. Unreinforced Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The Retaining Wall Installation Contractor shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.

3.04 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION

A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer's recommendations and these specifications, these specifications shall prevail.

B. Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.

C. Precast Modular Block Installation
1. The first course of block units shall be placed with the front face edges tightly abutted together on the prepared leveling pad at the locations and elevations shown on the con-

struction drawings. The Retaining Wall Installation Contractor shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.

2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks to a minimum distance of 12” (300 mm) behind the block unit.
3. Drainage aggregate shall be placed in 9 inch maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 2,000 lb (8.9 kN) of centrifugal force.
4. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.
5. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard item 4 above, for the base course blocks in this application.
6. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the retained soil (gravity wall design) or between the drainage aggregate and the reinforced fill (reinforced wall design) as required on the retaining wall construction drawings.
7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90 degree corner units, the shear channel of the upper block shall be fully engaged with the shear knobs of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Geogrid, drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.
8. The elevation of retained soil fill shall not be less than 1 block course (18” (457 mm)) below the elevation of the reinforced backfill throughout the construction of the retaining wall.
9. If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer’s recommendation.

D. Geogrid Reinforcement Installation (if required)
1. Geogrid reinforcement shall be installed at the locations and elevations shown on the construction drawings on level fill compacted to the requirements of this specification.
2. Continuous 12” (300 mm) wide strips of geogrid reinforcement shall be passed completely through the vertical core slot of the precast modular block unit and extended to the embedment length shown on the construction plans. The strips shall be staked or anchored as necessary to maintain a taut condition.
3. Reinforcement length (L) of the geogrid reinforcement is measured from the back of the precast modular block unit. The cut length (L_c) is two times the reinforcement length plus additional length through the block facing unit. The cut length is calculated as follows:

$$L_c = 2*L + 3 \text{ ft } (2*L + 0.9 \text{ m}) \text{ (28” (710 mm) block unit)}$$
$$L_c = 2*L + 5 \text{ ft } (2*L + 1.5 \text{ m}) \text{ (41” (1030 mm) block unit)}$$

4. The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths of 12” (300 mm)+/- ½” (13 mm). No field modification of the geogrid roll width shall be permitted.

5. Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 5 mph (8 km/hr) once a minimum of 9 inches (230 mm) of compacted fill has been placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.

E. Construction Tolerance. Allowable construction tolerance of the retaining wall shall be as follows:
   1. Deviation from the design batter and horizontal alignment, when measured along a 10’ (3 m) straight wall section, shall not exceed 3/4” (19 mm).
   2. Deviation from the overall design batter shall not exceed 1/2“ (13 mm) per 10’ (3 m) of wall height.
   3. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 1/2” (13 mm).
   4. The base of the precast modular block wall excavation shall be within 2” (50 mm) of the staked elevations, unless otherwise approved by the Inspection Engineer.
   5. Differential vertical settlement of the face shall not exceed 1’ (300 mm) along any 200’ (61 m) of wall length.
   6. The maximum allowable vertical displacement of the face in any precast modular block joint shall be 1/2“ (13 mm).
   7. The wall face shall be placed within 2” (50 mm) of the horizontal location staked.

3.05 WALL INFILL AND REINFORCED BACKFILL PLACEMENT

A. Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:
   1. 98% of maximum dry density at ± 2% optimum moisture content per ASTM D698 standard proctor or 85% relative density per ASTM D4254.

B. Compactive effort within 3’ (0.9 m) of the back of the precast modular blocks should be accomplished with walk-behind compactors. Compaction in this zone shall be within 95% of maximum dry density as measured in accordance with ASTM D698 standard proctor or 80% relative density per ASTM D 4254. Heavy equipment should not be operated within 3’ (0.9 m) of the back of the precast modular blocks.

C. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 9” (230 mm).

D. At the end of each work day, the Retaining Wall Installation Contractor shall grade the surface of the last lift of the granular wall infill to a 3% ± 1% slope away from the precast modular block wall face and compact it.

E. The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.

3.06 OBSTRUCTIONS IN THE INFILL AND REINFORCED FILL ZONE

A. The Retaining Wall Installation Contractor shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.

B. Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be constructed until the Retaining Wall Design Engineer can appropriately address the required procedures for construction of the wall section in question.

3.07 COMPLETION

A. For walls supporting unpaved areas, a minimum of 12” (300 mm) of compacted, low-permeability fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.

B. For retaining walls with crest slopes of 5H:1V or steeper, silt fence shall be installed along the wall crest immediately following construction. The silt fence shall be located 3’ to 4’ (0.9 m to 1.2 m) behind the uppermost precast modular block unit. The crest slope above the wall shall be immediately seeded to establish vegetation. The General Contractor shall ensure that the seeded slope receives adequate irrigation and erosion protection to support germination and growth.

C. The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Owner of any deviations.

END OF SECTION 323223

SECTION 323300 – 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. Section Includes:
   1. Standard Bicycle Rack
   2. Electric Bicycle Rack
   3. Trash and Recycling Receptacle
   4. Bollard

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 32 Section ‘Concrete Paving’
   3. Division 32 Section 'Unit Paving’

C. Warranty: Provide Manufacturer’s standard warranty.

1.3 ACTION SUBMITTALS

A. Product Data for the following: For each type of product indicated.
   1. Submit product literature or tear sheets giving name of product, manufacturer's name and compliance with Specifications.

B. Samples for Initial Selection: For units with factory-applied color finishes and other items involving color and finish selection.

C. Samples for Verification: For each type of exposed finish required.

D. Shop Drawings: showing fabrication and installation of benches and tiered seating including plans, elevations, details of components, and attachments to other units of Work. Indicate materials and profiles of each member, fitting, joinery, finishes, fasteners, anchorages, and accessory items.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Construct mockups as described in Quality Assurance section herein.

F. Maintenance and Cleaning Data: For site furnishings to include in maintenance manuals.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified installer and testing agency. Include list of completed projects with project names and addresses, names and addresses of Landscape Architects and owner, and other information specified.

B. Product Certificates: For each type of site furnishing, from manufacturer.

C. Guarantee: Obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. Guarantees shall be in addition to, and not in lieu of, other liabilities, which the Contractor may have by law or other provisions of the Contract Documents.

D. Maintenance Data: For site furnishings to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. General:
   1. Work of this Section shall be fabricated and installed by experienced fabricator(s) or manufacturer(s), who have been previously engaged in ornamental metal, or wood work of equal scope and fabrication standards to Project requirements.
   2. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices, and erection shall be in accordance with Project Contract Drawings and Specifications, approved shop drawings, and be of highest quality practices of the industry.
   3. Use new and clean materials as specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work shall be subjected.
   4. All work shall be accurately and neatly fabricated, assembled and erected with smooth finished surfaces.
   5. Field Measurements and Coordination: Verify dimensions with work specified in other sections which adjoins or to which this work will be attached.
      a. Effect coordination with related work of other sections, including work of other separate Contracts.
      b. Measurements of adjoining work shall be taken, so that work specified in this Section shall fit closely into the spaces and conditions provide.
      c. If any unusual conditions are encountered, the nature and location of conditions shall be shown on shop drawings submitted to Landscape Architect for determination and approval prior to fabrication.
   6. Coordination with other Trades: Coordinate with and furnish all necessary templates and patterns required by work of other sections. Furnish components of assemblies that are to be built into work specified as part of other sections. Supervise and be responsible for the correct location and installation of such built-in items.

B. Fabrication Qualifications: Fabrications shall be by a firm or firms which have successfully fabricated each material type and condition, similar to the quality specified, and in the quantity shown for a period of not less than five (5) years.

C. Installer Qualifications: Installers shall have a minimum of ten (10) years successful experience, either in the present business form or by having principal personnel with equivalent experience elsewhere, in the installation of the metal and wood materials specified, and the products, systems, and scope specified.

D. Welding: Procedures and personnel to the following:
   1. AWS D1.1, “Structural Welding Code – Steel”
   2. AWS D1.3, “Structural Welding Code – Sheet Steel”
   3. Certify that each welder has satisfactorily passed AWS qualification tests for the related processes, and if pertinent, has undergone certification.

E. Shop Assembly: Insofar as is practical, fitting and assembly of work shall be done in shop in order to minimize field splicing and assembly.
   1. Work that cannot be permanently shop-assembled shall be completely assembled, marked for re-assembly and disassembled in shop before shipment to ensure correct assembly in field.
   2. Shop assembles work in largest practical sizes to minimize field work.
   3. Shop fabricated items shall correctly fit the field condition. In event that shop- fabricated items do not fit the field condition, the item shall be returned to the shop for correction, unless otherwise approved by Landscape Architect.

F. This Specification Section does not define or establish the extent of work performed by sub-trades. Contractor shall assign sub trade work as he deems appropriate for a complete, coordinated, cost effective and proper execution.

G. 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.

H. Pre-installation Meeting: Before beginning the work of this section, schedule and conduct a meeting at Project site to review the Contract Documents, the approved submittals and other pertinent matters of the particular installation. Present shall be the Contractor, the installer, and the installer’s field foreman. Inform the Landscape Architect five (5) business days in advance of the scheduled meeting time.

I. Source Limitations: Obtain each type of site furnishing through one source from a single manufacturer where possible.

1.6 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Division 01 - General Requirements.

B. The Contractor shall be responsible for timing delivery of all site improvement items not requiring weathering, so as to minimize on-site storage time prior to installation. All stored materials and items must be protected from weather, careless handling and vandalism. Damaged items shall be repaired or replaced, as determined by the Landscape Architect.

C. Load and store primed and coated articles off the ground and under cover to prevent formation of wet storage film. Allow air between and around surfaces and allow for continuous drainage of units until installed and painted.

D. Protect finishes against soiling, staining, or damage from scratches and abrasion. Maintain protection during construction until project completion.

1.8 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.

B. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate Work of this Section with Work of all other Sections of Specifications.

1.10 CLOSEOUT REQUIREMENTS

A. Project Record Documents: Submit in accordance with Division 01 Section “Project Record Documents”.

B. Operations and Maintenance Data
   1. Provide Maintenance and Cleaning instructions for Owner.
   2. Provide manufacturer’s standard warranty.

PART 2 - PRODUCTS

2.1 BICYCLE RACK

A. Subject to compliance with requirements, provide standard bicycle racks as manufactured by Ground Control Systems, 708 Alhambra Blvd, Suite 200, Sacramento, CA, 95816, 1-800-630-7225, Fax: 1-866-532-9049, Website: www.groundcontrolsystems.com
   1. Model: DV215
   2. Color: Black
   3. Finish: Polyester Powder Coat
   4. Mount: Surface Mounted

2.2 ELECTRIC BICYCLE RACK

A. Subject to compliance with requirements, provide electric bicycle rack as manufactured by DERO BIKE RACK CO., 5522 Lakeland Ave. N., Minneapolis, MN 55429, 1-888-337-6729. Fax: 612-331-273. Website: www.dero.com.
   1. Model: Bikeep Smart Bike Parking Station
   2. Capacity: 5 Bikes
   3. Finish: Powder Coat
   4. Mount: Surface Mounted

2.3 TRASH AND RECYCLING RECEPTACLE

A. Subject to compliance with requirements, provide trash and recycling receptacle as manufactured by Landscape Forms, Inc., 7800 E. Michigan Ave, Kalamazoo, Michigan 49048. Phone: (800) 521-2546. Fax (269) 381-3455. Website www.landscapeforms.com.
   1. Model: Scarborough Litter Receptacle
   2. Style: Side-Opening, Vertical Strap.
   3. Mounting: Surface Mounted
   4. Finish: Powder Coat
   5. Color: Black
   6. Lids:
      a. Custom Opening and Ocean Blue Lid for Recycling Receptacle
      b. Black Lid for Landfill Receptacle

2.4 BOLLARD

A. Subject to compliance with requirements, 6” Flat Top Bollard Cover as manufactured by Barrier Defense Systems; Address 986 Rosedale Drive, Hiram, Georgia 30141; Telephone 678-915-2080
   1. Part Number: BC6F0630-4
   2. Cover Height: 30”
   3. Material: 316L Stainless Steel
   4. Finish: #4 Circumferential Brushed

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspection: Verify the conditions, elevations, and measurements affecting the work of this Section prior to installation. Examine surfaces to receive site furnishings and do not proceed until any defects detrimental to the finished work are corrected. Take proper precautions so as not to disturb or damage subsurface elements of utilities, conduits, underdrainage systems, water proofing, insulation, or foam fill.

B. Install all site improvements as per manufacturer’s instructions unless otherwise noted in specifications or shown on Drawings.

3.2 INSTALLATION

A. Install all site furnishing according to manufacturer's instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Install site furnishings level, plumb, true to line or radius, accurately fitted and located, with flush tight joints, with provision to allow for thermal movements, with provision to exclude water and with attachment devices as required for secure and rigid installation and securely anchored at locations indicated on Drawings.
   1. Make field assembly and connections with the same level of quality as shop fabricated work.
   2. Install work to provide items with capabilities to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected.
   3. Install, or coordinate with other work as required to install bases, grouts, fillers, flashings, sealants, and other components as the work progresses.

C. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

D. Restore protective coverings which have been damaged during shipment or installation of work. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at the same location.

E. Field Welding: Comply with the applicable AWS specification for procedures of manual shielded metal-arc welding, for appearance and quality of welds made.

3.3 ATTACHMENTS

A. All attachment devices shall be of type, size and spacing to suit condition and as approved by Landscape Architect. When exposed to view, finish shall match item attached.
   1. Provide shims, slotted holes, or other means necessary for leveling, plumbing, and other required adjustments.
   2. Mechanical Fastenings: Limit fasteners to concealed and inconspicuous locations as approved.

B. Do all necessary drilling, tapping, cutting or other preparation of surrounding construction in the field accurately, neatly, and as necessary for the attachment and support of work of this Section.

C. Do not cut or abrade finishes, which cannot be completely restored in the field, without the Landscape Architect’s approval. Do not weld fabrications after shop priming.

D. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

3.4 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day’s work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store

materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 323300

SECTION 328000 - IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Underground/roof garden irrigation system.
2. Pipe and fittings, valves, sprinkler heads, dripline, and accessories.
3. Automatic control system.
4. Excavation and backfilling for installation of underground system components.

1.2 SYSTEM DESCRIPTION

A. Layout design: Modify layout as needed to obtain required and complete coverage with manufacturer's standard heads as specified.
1. Provide irrigation layout with separate plant type zones:
    a. Lawns.
    b. Shrub/Groundcover Beds
2. Provide flow velocities that do not exceed 5.0 ft. per second.
3. Provide irrigation of lawn areas with no overspray into planting beds or pavements, unless so designed on the drawings.
4. Provide independent irrigation of individual bed zones or planters.

B. Only similar types of heads with matched precipitation rates may run on same zone.

C. Piping Design: Do not mix different heads for each line. Provide main size as needed for proper flow, but not less than specified on plan.

D. Provide electric solenoid controlled underground irrigation system manufactured especially for control of automatic circuit valves of underground irrigation system. Provide unit of capacity to suit number of circuits indicated.
    a. Source Power: 120 volts
    b. Low Voltage Controls: 24 volts AC.

E. Provide controller to control all zones.

F. The extent of the irrigation system is shown on the Drawings.

1.3 SUBMITTALS - REVIEW

A. Product Data: System components.

B. Shop Drawings:
1. Indicate piping layout to water source.
2. Include piping layout and details illustrating location and types of sprinkler heads, valves, control system and wiring, and schedule of fittings.
3. Indicate location of sleeves under pavements and conflicts with existing utilities.

C. Samples
1. Submit the following material samples:
    a. Piping and fittings.
    b. Wire connectors and sealer.
    c. Control wire.
    d. Sprinkler heads, one of each type, complete with housing.
    e. Drip tubing, 5' length minimum.
    f. Valves and access boxes.
    g. Controller.
2. Approved equipment samples will be returned to the Contractor and may be used in the work before final approval.

1.4 SUBMITTALS - CLOSE-OUT

A. Comply with the requirements of the General Conditions.

B. Record Drawings:
1. Indicate exact location of gate valves, wire splice locations; sprinkler head layout, automatic valves, quick couplers, sleeving under walks and roads and all irrigation and drainage piping, etc.
2. At the time of the irrigation mainline test, provide a preliminary set of “Record” drawings to the Owner’s Authorized Representative.

C. Operation and Maintenance Data:
1. Provide instructions for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer’s parts catalog.
2. Provide schedule indicating length of time each valve is required to be run to provide a determined amount of water.
3. Include complete parts list with manufacturer’s designations for each component.
4. Loose Equipment to Furnish: Loose irrigation equipment, operating keys and spare parts will be furnished by the Irrigation Contractor in quantities as shown on the plans.
5. Two (2) quick coupler keys and matching swivel hose ells.
6. Two (2) valve keys for gate valves.
7. Two (2) keys for each controller.

1.5 QUALITY ASSURANCE

A. Installer’s Qualifications: Single firm specializing in irrigation work with a minimum of five years’ experience properly installing irrigation systems of comparable size. Provide references of your last five consecutive systems, and five systems of comparable size with bid proposal.

B. Materials, equipment, and methods of installation shall comply with the following codes and standards:
1. City/State Building Codes.
2. American Society for Testing and Materials (ASTM).
3. National Sanitation Foundation (NSF).

C. Requirements of Regulatory Agencies:
1. All work and materials shall be in full accordance with the latest rules and regulations of safety orders of Division of Industrial Safety; the Uniform Building Code and other applicable laws or regulations, including any local Plumbing Codes.
2. Should the Contract documents be at variance with the aforementioned rules and regulations, notify the Owner’s authorized representative for instructions before proceeding with work affected.

D. Testing:
1. Preliminary review of completed installation will be made prior to backfilling of trenches and hydrostatic testing.
2. Final review and testing shall be made in conjunction with the final review of lawn, shrub, and tree planting.

E. Permits and Inspections:
1. Any permits for the installation or construction of any work included under this contract, which are required by any of the legally constituted authorities having jurisdiction, shall be obtained and paid for by the contractor, each at the proper time.
2. The Contractor shall also arrange for and pay all costs in connection with any inspection and examination required by these authorities.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver irrigation system components in manufacturer’s original, undamaged, and unopened containers, with labels intact and legible.

B. Deliver plastic pipe in bundles, packaged to provide adequate protection of pipe ends.

C. Store and handle materials to prevent damage and deterioration.

D. Provide secure, locked storage for valves, sprinkler heads and similar components that cannot be immediately replaced to prevent installation delays.

E. Contractor is responsible for materials through final acceptance.

1.7 PROJECT CONDITIONS

A. Protect existing trees, plants, and lawns and other features designated to remain as part of the final landscape.

B. The Contractor shall carefully coordinate with the landscape work and other site developments, including all new and existing utilities.

C. The Contractor shall verify the correctness of all finish grades within the work area to ensure the proper soil coverage of the irrigation pipes.

D. Irrigation system layout is diagrammatic. Exact location of piping, sprinkler heads, valves, and other components shall be established by Contractor in the field at time of installation.

E. Space sprinkler components as indicated. Do not exceed sprinkler spacing shown on Drawings.

F. Locate existing utilities in areas of work. If utilities are to remain, provide adequate means of protection during the system installation. Repair utilities damaged during the work to the satisfaction of the Utility Owner and at the Contractor's expense. Notify local Utility Protection Service three days prior to beginning excavation work.

G. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, notify the Owner's Authorized Representative immediately for direction as to procedure. Cooperate with the Owner and Utility companies in keeping active services and facilities in operation.

H. Minor adjustments in system layout will be permitted to clear existing field obstruction. Final system layout shall be acceptable to the Owner's Authorized Representative.

1.8 WARRANTY

A. Warranties are subject to the General and Supplementary Conditions.

B. Irrigation Contractor is responsible to ensure complete coverage as specified herein of the areas to be irrigated. During the warranty period the Irrigation Contractor shall make any adjustments as necessary to maintain proper coverage.

C. If, within one year from the date of completion, settlement occurs, and adjustments in pipes, valves and sprinkler heads, lawn areas or paving are necessary to bring the system, grade or paving to the proper level of the permanent grades. The Contractor, as part of the work under his Contract, shall make all adjustments without extra cost to the Owner, including the restoration of all damaged planting, paving or other improvements of any kind.

D. Should any operational difficulties in connection with the irrigation system develop within the specified guarantee period, which, in the opinion of the Owner's Authorized Representative may be due to inferior material and/or workmanship, said difficulties shall be immediately corrected by the Contractor to the satisfaction of the Owner at no additional cost to the Owner, including any and all other damages caused by such defects.

1.9 OPERATION & MAINTENANCE — IRRIGATION SYSTEM

A. The entire irrigation system shall be under fully automatic operation for a period of three days prior to any planting.

B. It is the Landscape Contractor's responsibility to determine water application rates and controller cycling. The Irrigation Contractor will instruct the Landscape Contractor on the operation

and programming of the controller and will assist the Landscape Contractor as necessary in such operations throughout the one-year maintenance period. Any adjustments, repairs, etc., other than programming are the total responsibility of the Irrigation Contractor.

C. The Irrigation Contractor shall service the system at the request of the Owner's Authorized Representative during the guarantee period and shall be paid for work performed which is not covered by the guarantee. The Irrigation Contractor shall winterize the system the first year as part of this contract and provide written instructions to the Owner's Authorized Representative for future service and maintenance.

D. The Irrigation Contractor shall return to the site during the subsequent spring season and demonstrate to the Owner's Authorized Representative the proper procedures for the system start-up, operation, and maintenance.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos. Polychlorinated biphenyl (PCB) or other hazardous materials identified by the Owner.

2.2 IRRIGATION SYSTEM MANUFACTURERS

A. All irrigation system components shall be supplied by regionally authorized distributors to provide single source responsibility for warranty service and operations to conform to specifications in all aspects. Unless specifically stated otherwise, the Irrigation Contractor may assume the phrase "Acceptable Substitute," except that the burden is upon the Contractor to prove such equality. If the Contractor elects to prove such equality, he/she must request the Landscape Architect's and the Owner's Authorized Representative's approval in writing (one week prior to bid) to substitute such item for the specified item, stating the cost difference involved with supporting data and samples to permit a fair evaluation of the proposed substitute with respect of quality, serviceability, warranty, and cost. If sprinkler heads or remote-control valves are requested to be substituted, each zone affected by such substitution shall be recalculated for pressure loss, GPM, and shall be submitted to the Owner's Authorized Representative for his review.

2.3 MATERIALS

A. All materials to be incorporated in this system shall be new and without flaws or defects and of quality and performance as specified and meeting the requirements of this system.

B. Plastic Pipe

1. All piping shall be from virgin parent material. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious wrinkles, and dents.
2. For all irrigation piping, use polyvinyl chloride (PVC) 1120 with a minimum class rating of 200, sized to maintain a maximum flow velocity of less than 5 ft. per second (FPS).
3. Pipe shall be marked at intervals (not to exceed 5') with the following information: Manufacturer's name or trademark, nominal pipe size, schedule, PVC type and grade (i.e., PVC 1120), SDR rating class rating.
4. When connection is plastic to metal, male adapters shall be used. The male adapter shall be hand tightened, plus one turn with a strap wrench.
5. Comply with pipe sizes indicated on drawings. No substitution of smaller pipe will be permitted. Larger sizes may be used subject to acceptance of the Owner's Authorized Representative. Remove damaged and defective pipe from site.
6. All PVC pipe to be furnished in 20' lengths.

C. Piping for Sleeving

1. For sleeves under six inches (6”) in size, high impact type, polyvinyl chloride (PVC) 1120, minimum Schedule 40.
2. For sleeves six inches (6”) and above in size shall be Polyvinyl Chloride (PVC) 1120 Class 200.
3. Irrigation Contractor shall be responsible for the coordination of sleeves for all piping passing through concrete curbing, under paved areas, concrete or masonry walls and floors while the same are under construction.

D. Fittings
1. Fittings for Solvent -weld PVC Pipe
    a. Schedule 40 or 80, polyvinyl chloride (PVC), Type 1 injection molded fittings suitable for solvent weld or threaded connections, to meet ASTM standards, NSF approved. Fittings made of other materials are not permitted.
2. Threaded PVC nipples shall be Schedule 80. Use high quality grade of Teflon tape for threaded fittings.
    a. Saddle fittings are not permitted.
    b. Use high quality grade of Teflon tape for sprinkler head and electric remote control valve connections.

E. Isolation Valves
1. Gate valves under 3” shall be 200 psi rated W.O.G. 200 domestically manufactured with bronze bodies. Valves shall be equipped with tee handles. As manufactured by Watts Regulator or approved equal.

F. Master valve
1. Rainbird 300-BPES compatible with IQ control system.

G. Quick Coupling Valves
1. Valve shall be 1” female.
2. Acceptable Products:
    a. Rain Bird model 5RC or approved equal.
3. Furnish one valve key fitted with 1” swivel hose ell.
4. Acceptable Products:
    a. Rain Bird model 55K-1.
5. All quick coupling valve keys and hose swivels shall be of the same manufacturer as the quick coupler.

H. Valve Boxes
1. Tapered rib reinforcement enclosure of rigid tensile strength plastic material components chemically inert and unaffected by moisture, ultraviolet light, corrosion, and temperature changes. Lid and base shall withstand normal loads exerted by turf equipment without collapsing. Lid to be green in color.
2. Acceptable Manufacturers:
    a. Armor
    b. NDS
    c. Rain Bird
3. For remote control valves and quick coupler valves use rectangular standard turf box, 16” x 12”.
4. For Isolation valves use 10” circular turf box.
5. For green roof valves use boxes indicated on the drawings.

I. Spray heads
1. Description: Manufacturer's standard spray bodies designed to provide uniform coverage over entire area of spray shown on drawings at available water pressure or as follows:
2. Parts and components to withstand harsh operating conditions using chemically treated recycled water (reclaimed/non-potable), dirty water containing grit, debris, and other particulates, high operating pressures common in commercial irrigation and resistant to ultra-violet light.
3. Parts and components resistant to corrosion in treated recycled water containing chlorine and other chemicals.
4. Wiper seal material shall resist degradation caused by chlorine in reclaimed water.

5. Sprinkler shall have an operating pressure range of 15 to 100 PSI and shall include a ½" NPT female threaded bottom inlet.
6. Exposed cover shall be purple to indicate the use of non-potable water.
7. All spray body components shall be removable from the top without special tools in order to provide quick and easy flushing and maintenance of the sprinkler.
8. The spray body, stem, nozzle, and screen shall be constructed of ultra-violet resistant plastic.
9. It shall have a heavy-duty stainless steel retract spring for positive pop-down.
10. The spray body shall have a pre-installed flush plug.
11. When indicated on the Drawings, the sprinklers shall have an integral check valve (SAM device) capable of holding back 8' of elevation.
12. The plug shall prevent debris from clogging the sprinkler during installation and allow for the system to be flushed before nuzzling.
13. The plug shall be bright orange in color and constructed of polypropylene material.
14. Pop-up heights: 4 inches (see drawings).
15. Acceptable Products:
    a. Rain Bird RD04-S-P30-FN or RD1804SAM-P45-NP or approved equal.
16. Spray nozzles for sprinkler heads shall be of the same manufacturer as the spray head.

J. Short-Range Turf Rotors
1. The full or part circle rotor sprinkler shall be a single stream, water lubricated, gear drive.
2. The sprinkler shall have an integral flow shutoff device that shall be capable of restricting the flow from the head by using a standard flat-bladed screwdriver.
3. The sprinkler shall have adjustable arc coverage from 40 to 360 degrees in one unit.
4. The sprinkler shall have a pressure-activated multi-function wiper seal that positively seals against the nozzle flange to keep debris out of the rotor and to clean debris from the pop-up stem as it retracts. The wiper seal shall prevent sprinkler from sticking up and be capable of sealing the sprinkler cap to sprinkler body under normal operating pressures.
5. The sprinkler shall be fully adjustable from the top using only a flat-blade screwdriver.
6. The sprinkler shall have a screen attached to the drive housing to filter inlet water, protect the drive from clogging and simplify its removal for cleaning and flushing of the system. It shall have a 1/2" (FNTP) bottom inlet.
7. The sprinkler shall have a stainlesss-steel adjusting screw capable of reducing the radius up to 25%.
8. The sprinkler shall have a strong stainless steel retract spring for positive pop down.
9. Acceptable Product:
    a. Rain Bird 3500-SAM-PC or approved equal.

K. Mid-Range Turf Rotors
1. The full or part circle rotor sprinkler shall be a single stream, water lubricated, gear drive.
2. The sprinkler shall have adjustable arc coverage from 40 to 360 degrees in one unit.
3. The sprinkler shall have a pressure-activated multi-function wiper seal that positively seals against the nozzle flange to keep debris out of the rotor and to clean debris from the pop-up stem as it retracts. The wiper seal shall prevent sprinkler from sticking up and be capable of sealing the sprinkler cap to sprinkler body under normal operating pressures.
4. The sprinkler shall be fully adjustable from the top using only a flat-blade screwdriver.
5. The sprinkler shall have a screen attached to the drive housing to filter inlet water, protect the drive from clogging and simplify its removal for cleaning and flushing of the system. It shall have a ¾" (FNTP) bottom inlet.
6. The sprinkler shall have a stainless-steel adjusting screw capable of reducing the radius up to 25%.
7. The sprinkler shall have a strong stainless steel retract spring for positive pop down. It shall have a check valve to check 7 feet of elevation change (if specified on the Drawing).
8. When indicated on the Drawings, the sprinklers shall have an integral check valve (SAM device) capable of holding back 8' of elevation.
9. Acceptable Product:
    a. Rain Bird model 5004+-SAM-R or approved equal.

L. Drip Tubing

1. Tubing shall consist of nominal sized one-half inch low density, linear polyethylene tubing, housing internal pressure compensating, continuously self-flushing, integral drip emitters.
2. The tubing shall be brown in color and conform to an outside diameter (O.D.) of 0.67 inches, and an inside diameter (I.D.) of 0.57 inches. The emitters shall have the ability to independently regulate discharge rates, with an output pressure of 7 to 70 PSI, at a constant flow.
3. The emitter discharge rate shall be 0.61 gallons per hour utilizing a combination turbulent flow/reduced pressure compensation cell mechanism and a diaphragm to maintain uniform discharge rates. The emitters shall continuously clean themselves while in operation. The dripline shall have *18"* spacing between emitters as noted on drawing.
4. Acceptable Product:
    a. Rain Bird XFS-06-18 or approved equal.
    b. Drip Control Valves as shown on irrigation plan.

M. Automatic Controller

1. The irrigation system controller shall be of a modular hybrid type that combines electro-mechanical and microprocessor-based circuitry capable of fully automatic and manual operation.
2. The controller will be housed in a weatherproof, lockable plastic cabinet.
3. The controller shall operate on a 117 VAC ± 10% power input and be capable of actuating up to two 24 VAC, 7VA solenoid valves per station plus a master valve or pump start relay. The controller shall be capable of operating four stations plus the master valve simultaneously. Controller output shall be protected against severe electrical surge.
4. The controller shall have four separate irrigation programs (A, B, C, D) which can have different start times, watering days, day cycles, and station timing. Each program shall have eight start times per day.
5. The controller shall have base capability of 8 stations and shall be expandable up to 32 stations, with each station capable of an operating time of 0 to 2 hours in one-minute increments and 2 to 12 hours in 10-minute increments. Controller station operation shall be of automatic sequential stacking to avoid overlapping operation unless programmed to overlap.
6. The controller shall have a 365-day calendar with day-of-the month OFF feature. Programs will run on an ODD/EVEN day cycle, day-of-the-week ON/OFF cycle, or in cycles from 1 to 99 days. In addition, the controller shall have a programmable rain shutdown from 1 to 99 days.
7. The controller shall be capable of being operated manually at any time. A manual single station, a group of stations or a program can be selected to run for the programmed time without affecting the normal program. This controller shall be capable of running a variable system test program without affecting the normal program.
8. The controller shall have an internal non-volatile memory, which will retain the irrigation program and the programmed date and time without power. A 9 VDC rechargeable battery and recharging circuit shall also be included for counting down the program-in-progress during power outage and shall allow programming of the controller when it is disconnected from the main power supply.
9. There shall be a station status indicator light and a master valve status indicator light. These lights will indicate station operation and circuit integrity. An indicator for sensor status will be found on the front panel along with a switch to suspend sensor operation. This indicator and override will work with a sensor wired to the controller's sensor terminals.
10. Acceptable Product:
    a. Rain Bird model ESP-LXD-LXMM with IQ cartridge, NCC Ethernet Cartridge.

N. Flow Sensor

1. One device shall be provided for each controller, installed per manufacturer's latest printed instructions.
2. Verify with Landscape Architect as to final location.
3. Acceptable Product:
    a. Rain Bird model FS150B or approved equal compatible with IQ control system.

O. Rain Sensor

1. One device shall be provided for each controller, installed per manufacturer's latest printed instructions.
2. Verify with Landscape Architect as to final location of rain shutoff.
3. Acceptable Product:
    a. Rain Bird model WR2-RC or approved equal.

P. Control Wire
1. Two conductors of single strand solid copper wire type, with PVC jacket. UF 600-volt AWG #14 minimum size, approved for direct burial. For runs over 2,000 L.F. use AWG #12. Contractor is to verify that wire sizes are within recommended wire run lengths for proper solenoid operation.

Q. Line Decoders
1. The factory pre-coded decoders shall be fully waterproof and have a working range shall be 0 degrees C to 50 degrees C at up to 100% humidity.
2. Decoders shall be capable of operating from one to six solenoids depending on the model specified on the Drawings.
3. Four and six address decoders shall have integral surge protection.
4. Acceptable Product:
    (a) Rain Bird LD series

R. Splicing Material
1. Splicing material shall be 3M Direct Bury (DBY) splice kits as manufactured by 3M Corporation or approved equal. Use DBR for larger wires.

S. Remote Control Valves
1. The remote-control valve shall be normally closed 24 VAC 50/60-cycle solenoid actuated globe pattern. The pressure rating shall not be less than 200 PSI.
2. The valve shall have a self-cleaning stainless-steel screen designed for use in dirty water applications.
3. The valve body and bonnet shall be constructed of heavy-duty glass-filled nylon and have stainless steel screws; diaphragm shall be of nylon reinforced nitrile rubber.
4. The valve shall have both internal and external manual open/close control (internal and external bleed) to manually open and close the valve without electrically energizing the solenoid. The valve's internal bleed shall prevent flooding of the valve box.
5. The valve shall house a fully encapsulated, one-piece solenoid. The solenoid shall have a captured plunger with a removable retainer for easy servicing, and leverage handle for easy turning. This 24 VAC 50/60 Hz solenoid shall open with 19.6-volt minimum at 200 PSI.
6. The valve shall have a stainless-steel flow control stem for accurate manual regulation and/or shut-off of outlet flow. The valve must open or close in less than 1 minute at 150 PSI.
7. The valve construction shall be such as to provide for all internal parts to be removable from the top of the valve without disturbing the valve installation.
8. The valve shall have a purple flow control handle to indicate that non-potable water is being used.
9. Acceptable Product:
    a. Rain Bird PGA or approved equal, sized as noted on Drawing.

R. Accessory materials
1. Drainage fill at valve boxes:
    a. Provide 1/2" to 3/4" washed pea gravel.
2. Trench backfill:
    a. Conform to requirements of backfill materials as specified in other sections.
3. Suitable excavated materials removed to accommodate the irrigation system work shall be used as fill materials provided it conforms to the requirements of fill as noted above.

S. PVC Solvent Cement:
1. Provide professional grade cement, Whitlam #PR32 or acceptable Substitute for PVC pipe and fittings.

T. PVC Primer/Cleaner

1. Provide professional grade primer/cleaner, Whitlam #PP32 or acceptable Substitute (purple) primer.

U. Green Roof Tray Irrigation System
1. Provide complete irrigation system with all components indicated on the drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide sleeves wherever piping or electrical wires are placed under paved surfaces.

B. Lay out work as accurately as possible to Drawings. Drawings are diagrammatic to the extent that swing joints, offsets, and fittings are not shown.

C. The Irrigation Contractor shall carefully schedule his work with the Landscape Contractor and all other site developments.

D. Sleeves are required wherever piping or electrical wires are placed under paved surfaces (installed as part of other sections and Contract). Irrigation Contractor is responsible for coordination of all sleeves.

E. Full and completed coverage is required. Contractor shall make any necessary minor adjustments to layout as required to achieve full coverage of irrigated areas at no additional cost to the Owner.

F. Where piping is shown on drawings to be under paved areas but running parallel and adjacent to planted areas, the intent is to install piping in planted areas. Do not install directly over another line in the same trench.

G. It shall be the Contractor's responsibility to establish the location of all sprinkler heads in order to assure proper coverage of all areas. In no case shall spacing of sprinkler heads exceed distances shown on the drawings and/or those specified. Pipe sizes shall conform to those shown on drawings. No substitution of smaller pipe sizes will be permitted, but substitutions of larger sixes may be approved. All pipe damaged or rejected because of defects shall be removed from the site at the time of said rejection.

H. Install irrigation system after completion of site grading, the irrigation system shall be installed and completely operational three days prior to the installation of any planting operations.

3.2 EXCAVATING AND BACKFILLING:

A. All piping is to be trenched, other than 1" which may be pulled.

B. Excavate to depths required to provide 2" depth of sand bedding material for piping when unsuitable bearing materials are encountered.

C. Should utilities not shown on the plans be found during excavations, the Contractor shall promptly notify the Owner's Authorized Representative for instructions as to further action. Failure to do so will make Contractor liable for any and all damage thereto arising from his operations subsequent to discovery of such utilities. Indicate such utility crossings on the record drawings promptly.

D. Install main line irrigation lines with a minimum cover 16" and a maximum cover of 24" based on finished grades.

E. Install lateral irrigation lines with a minimum cover of 12" and a maximum cover of 24" based on finished grades.

F. Perform all excavations as required for installation of work included under this Section, including shoring of earth banks, if necessary. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations, to their original condition.

G. Trenches shall be open, vertical sided construction wide enough to provide free working space around work installed and to provide adequate space for backfilling and compacting.

H. When two pipes are to be placed in the same trench, a 6” space is to be maintained between the pipes. The Contractor shall not install two pipes with one directly above the other.

I. The Contractor shall cut trenches for pipe to required grade lines and compact trench bottom to prove accurate grade and uniform bearing for the full length of the line.

J. The Contractor shall be held responsible for damages caused by these operations and shall immediately repair or replace damaged parts.

3.3 PIPELINE ASSEMBLY

A. General

1. Install pipes and fittings in accordance with manufacturer’s latest printed instructions.
2. Clean all pipes and fittings of dirt, scales, and moistures before assembly.
3. All pipe, fittings, and valves, etc., shall be carefully placed in the trenches. Interior of pipes shall be kept free from dirt and debris and when laying is not in progress, open ends of pipe shall be closed by approved means.
4. All lateral connections to the main line as well as all other connections shall be made to the side of the main line pipe. No connections to the top of the line shall be allowed.

B. Solvent-Welded Joints for PVC Pipe

1. Use solvents and methods approved by solvent and pipe manufacturers.
2. Cure joint a minimum of one hour before applying any external stress on the piping and at least 24 hours before placing the joint under water pressure, unless otherwise specified by the manufacturer.
3. Cut all pipe with square ends and remove burrs, ridges, and dirt. Check dry fit pipe and fitting. Clean pipe and fitting with purple primer and apply thin coat of cement to fitting with a liberal coat to pipe. Quickly push pipe fully into fitting using a 1/4 turning motion. Hold pipe and fitting together a minimum of 30 seconds, wipe off excess with cloth.

C. Threaded Joints for PVC Pipe

1. Use Teflon tape on all threaded PVC fittings.
2. Use strap-style friction wrench only. Do not use metal-jawed wrench.

D. Laying of Pipe

1. Pipes shall be bedded in at least in at least 2” of finely divided material with no rocks or clods over 1” diameter to provide a uniform bearing.
2. Pipe shall be snaked from side to side of trench bottom to allow for expansion and contraction. One additional foot per 100 feet of pipe is the minimum allowance for snaking.
3. Do not lay PVC pipe when there is water in the trench.
4. Plastic pipe shall be cut with PVC pipe cutters or hacksaw, or in a manner so as to ensure that a square cut. Burrs at end cuts shall be removed prior to installation so that a smooth unobstructed flow will be obtained.
5. All plastic-to-plastic joints will be solvent-weld joints or slip seal joints. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the Contractor’s responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The Contractor shall assume full responsibility for the correct installation.

3.4 PVC SLEEVES AND ELECTRICAL CONDUIT

A. Provide all sleeves indicated and as otherwise required for the successful completion of the irrigation system. Coordinate sleeving efforts with General Contractor and the Owner's Authorized Representative.

B. All PVC sleeves shall be a minimum of twice the diameter of pipe to be sleeved.

C. All PVC control wire conduit shall be of sufficient size to hold the required quantity of control and common wires. Electrical wires are not to be placed in the same trench with water pipes.

3.5 ISOLATION VALVES

A. Shall be located in the following locations:
1. After backflow preventer and prior to main supply loop.
2. Between main line and each remote-control valve.
3. Between main line and each quick coupler valve.
4. As located on irrigation system drawings within lawn areas.

B. Install each isolation valve in an individual valve box with a 6" (deep) layer of washed gravel below the bottom of the valve.

C. Seal threaded connections with Teflon tape.

3.6 IRRIGATION CONTROL VALVES
1. Install control valves in valve boxes grouped together where practical. Place no closer than 12" to walk edges, buildings, and walls.
2. All irrigation control valves shall be installed with ductile iron service tees (if mainline is 3" or larger).
3. Install line size bronze gate valve on pressure side of each control valve. Locate in valve box with control valve.
4. Install each electric control valve in an individual valve box with a 6" (deep) layer of washed gravel below the bottom of the valve.
5. Seal threaded connections with Teflon tape.
6. Valves shall be installed as shown in detail and in accordance with manufacturer's instructions and specifications.

3.7 QUICK COUPLING VALVES
1. Shall be set a minimum of 12" from walks, curbs, or paved areas where applicable or as otherwise noted. Quick coupling valves shall be housed in standard size valve boxes.
2. All quick coupler valves shall be installed on to ductile iron service tee.
3. Install 1" bronze gate valve on pressure side of each quick coupler valve. Locate in valve box with quick coupler valve.
4. Valves shall be installed on a three-elbow PVC Schedule 80 swing joint assembly.
5. Provide 6" (deep) layer of washed gravel below the bottom of the valve. Top of quick coupler valves shall be as close to the top of the valve box as possible. Top of gravel layer shall be 3" below the top of the valve.
6. Quick coupling valves shall be set perpendicular to finished grade unless otherwise designated on the plans.

3.8 VALVE BOXES

A. Valve boxes shall be set flush with grade in lawn areas and 1/2" above finish grade in ground cover and shrub bed areas.

B. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the valve box.

3.9 SPRAY HEADS AND ROTORS

A. All sprinkler heads shall be pop-up type heads. Permanent shrub risers are not permitted.

B. All sprinkler heads within a zone shall have matched precipitation rates.

C. Install plumb to within 1/16”, unless otherwise noted (see detail for heads on sloped areas on detail sheet). Top of collar (not nozzle) should be flush with finish grade.

D. Place part-circle pop-up sprinkler heads at least 2” and no more than 6” from edge of adjacent walks, curbs and mowing bands, or paved areas at time of installation.

E. Install pop-up sprinkler heads, and accessories in accordance with manufacturer’s latest printed instructions, except as otherwise noted.

F. All sprinkler nozzles shall be adjusted for the proper radius and direction of spray pattern. Make adjustments where possible to prevent over spraying onto walks, pavement or buildings.

G. Tighten nozzles on spray type sprinklers after installation. Adjust sprinkler adjusting screw as required for proper radius.

H. Install pop-up spray heads with approved flexible thick wall polyethylene swing pipe with spiral barb fittings. Do not install to side inlet of sprinkler head.

I. Polyethylene swing joints are not to be used to extend head more than 18” from lateral.

J. Heads to be installed at the top of a slope shall be tilted toward the toe of the slope. They shall also be installed slightly down from the top edge of the slope to decrease wind drift.

K. Mid-slope sprinkler heads shall be installed at an angle halfway between vertical and perpendicular to the slope. For example, a 2:1 or 50% slope has an angle of 26 degrees, so tilt the heads 13 degrees into the slope from the perpendicular.

L. Heads installed at the toe of the slope shall be tilted slightly away from the slope to avoid driving water into the slope directly in front of the sprinkler.

M. Do not mix different types of heads within a zone.

3.10 DRIP TUBING

A. Tubing is designed for use in surface and sub-surface applications utilizing a grid design, the result being a complete wetted area within the grid. It can also be installed as single or “snaked” lines where grids are not justified. The most uniform way to install tubing is sub-surface at a uniform depth as specified.

B. The drippers are designed to regulate flow at the specified output from 7 to 70 PSI with maximum recommended pressure of 45 PSI when using unclamped insert fittings. The choice of dripper spacing and lateral spacing is dependent on the soil type and plants being used. See drawing for details.

C. Dripline shall be staked down using 6” galvanized sod staples. Staples shall be spaced no further than 24” on center, but the contractor will place staples as closely as necessary to ensure that dripline will not work its way to the surface.

3.11 AUTOMATIC CONTROLLER

A. The automatic controller shall be installed at the approximate location shown on the drawings.

B. Install per local code, manufacturer’s latest printed instructions, and as detailed.

C. Valve wires shall be neatly stripped to expose 1/4” of copper conductor for connections to the controller terminal strip. The common wire shall be connected directly to the controller’s common terminal.

D. Valve control wires shall be numbered at the terminal strip.

3.12 CONTROLLERS POWER SUPPLY & DATA CONNECTION

A. Power to the controller(s) shall be supplied from a dedicated circuit, installed as part of work of other sections and Contract.

B. Data connection to the controller(s) shall be supplied, installed as part of work of other sections and Contract. Provide 2D from CNS Entry to building. Provide typical backbox, rough-in installation. Extend cables from terminated faceplate as required to irrigation controller.

3.13 CONTROL WIRING

A. All electrical equipment and wiring shall comply with local and state codes and be installed by those skilled and licensed in the trade.

B. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines whenever possible and shall have a minimum of 12” cover.

C. Control wires shall be installed to the side of the main line whenever possible. Placement over pipes is not permitted.

D. Where more than one wire is placed in a trench, the wiring shall be taped together at intervals of 20’.

E. An expansion curl shall be provided within 3’ of each wire connection and at least every 100’ of wire length on runs of more than 100’ in length. Expansion curls shall be formed by wrapping at least five turns of wire around a 1” diameter pipe, then withdrawing pipe.

F. Control wire splices at remote control valves to be crimped and sealed with specified splicing materials. Line splices will be allowed only on runs of more than 500’ and they must be located in10” round splice boxes which are green in color. The connector shall be 3M DBY splice kit by 3M Corporation, or accepted Substitute. Use one splice per connector sealing pack.

G. The main line shall have two spare wires installed its entire length and to the automatic controller. Label each end “spare wire.” Spare wires to be blue in color.

H. Tracer Wire shall be run the Entire Length of the Mainline.

3.14 RAIN SENSOR

A. Install one sensor in a location approved by the Owner’s Authorized Representative and connect to the irrigation system.
1. All exposed wire shall be installed in metal electrical conduit.

3.15 CLOSING OF PIPE AND FLUSHING OF LINES

A. All testing shall be done under the supervision of the Owner’s Authorized Representative. Submit written requests for inspections to the Owner’s Authorized Representative at least three days prior to anticipated inspection date.
1. Thoroughly flush out all water lines under a full head of water before installing heads, valves, quick coupler assemblies, etc. Maintain flushing for a minimum of three minutes at the valve located furthest from water supply.
2. After flushing, cap or plug all openings to prevent entrance of materials that would obstruct the pipe or clog heads. Leave in place until removal is necessary for completion of installation.
3. Test as specified below.
4. Upon completion of testing, complete assembly and adjust sprinkler heads for proper distribution.

3.16 TESTING

A. Make hydrostatic when welded PVC joints have cured as per manufacturer’s instructions.
1. Pressurized mainlines:
    a. Completely install water meter, mains, isolation valves and control valves. Do not open laterals.
    b. Open all isolation valves.
    c. Fill all lines with water and shut off at meter.

d. Pressurize the main with air to 70 PSI. monitor gauge for pressure loss for a minimum of four hours.
e. Leave lines and fittings exposed throughout testing period.
f. Leaks resulting from tests shall be repaired and tests repeated until the system passes.
g. Test all isolation valves for leakage.

B. Non-pressurized laterals:
a. Test piping after laterals and risers are installed and system is fully operational.

3.17 INSPECTIONS

A. The contractor shall maintain proper facilities and provide safe access for inspection to all parts of the work.

B. Irrigation inspection shall consist of a minimum of:
a. Mainline pressure test.
b. Coverage test.
c. Final irrigation inspection.

C. If the specifications, the Owner's Authorized representative's instructions, laws, ordinances, or any public authority require any work to be tested or approved, the contractor shall give the Owner's Authorized Representative three days' notice of its readiness for inspection.

D. The contractor shall be solely responsible for notifying the Owner's Authorized Representative where and when such work is in readiness or testing.

E. If any work should be covered up without the approval of the Owner' Authorized Representative it must be uncovered, if required, for examination at the contractor's expense.

F. No inspection will commence without "Record" drawings and without completing previously corrections, or without preparing the system for inspection.

3.18 BACKFILLING AND COMPACTING

A. After system is operating and required tests and inspections have been made, backfill trenches.

B. Backfill for all trenches, regardless of the type of pipe to be covered, shall be compacted to minimum 95 percent density under pavements, 85 percent under planted areas.

C. Backfill material shall be suitable material. Unsuitable material, including clods and rocks over 2" in size shall be removed from the site.

D. A fine granular material shall be placed initially on all lines with a minimum of 3" cover. No foreign matter larger than 1/2" in size shall be permitted in the initial backfill.
1. Trenches located under paving shall be backfilled with sand (a layer 6" below the pipe and 3" above the pipe) and compacted in layers of 95 percent compaction.
2. Compact trenches in areas to be planted, by thoroughly flooding the backfill.
3. Within all planting and lawn areas, the existing four 4" layer of topsoil shall be restored to its original condition and finish grade.
4. Surplus earth remaining after backfilling shall be disposed of off-site by the contractor.

3.19 CLEANING AND DISPOSAL OF WASTE MATERIAL

A. Perform clean-up during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment as fast as it accumulates.

B. Restore and repair all disturbed or damaged areas resulting form irrigation installation operations to original condition in a manner acceptable to the Owner's Authorized Representative.

C. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.

END OF SECTION 328000

SECTION 329113 – PLANTING SOIL SYSTEMS (STRUCTURAL SOIL)

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. Evaluation of rough subgrade water infiltration.
2. Planting soil material procurement.
3. Testing and analysis for specification conformance.
4. Inspection and testing of subgrade for preparation of subgrade.
5. Preparation of mixes and testing for conformance.
6. Installation of soils.
7. De-compaction of soils.
8. Mock-up of planting soil profiles.
9. Final in-place testing of soils.

B. Related Requirements:
1. Division 32 Section ‘Concrete Paving’
2. Division 32 Section ‘Unit Paving’
3. Division 32 Section ‘Metal Edging’
4. Division 32 Section ‘Exterior Planting’

1.3 DEFINITIONS

A. Compaction: Compaction of soil is any force applied to the soil that reduces porosity and where 90 percent of all compaction can be accomplished with only three applications of force under optimum soil moisture conditions.

B. Dry Soil: The condition of the soil where available water is at or below a plant’s wilting point; the soil is powdery and subject to blowing.

C. Frozen Soil: The point at which the soil water has frozen and the soil has become very hard and cloddy. Ice crystals can be seen in the pore spaces of the soil.

D. Field Capacity: The percentage of water remaining in a soil two or three days after having been saturated and gravitational drainage has ceased.

E. Moist Soil: The condition of the soil when it can be formed into a ball and maintain its shape. Deformation of the soil is difficult with hand pressure. Free water is not visible; usually considered the point between the wilting point and field capacity of the soil.

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. Saturated: All the pore space within a soil is filled with water and the remaining water is under gravitational forces to drain through the profile.

H. Scarification: The loosening of the surface of a soil by mechanical or manual means to alleviate compaction of the soil surface. Depth of scarification is dependent on material and extent of compaction. Depths are noted within the specifications.

I. Subsoil: The soil layer directly below topsoil that provides water holding and structural support to plants. Source of the majority of micro-nutrients.

J. Sub-grade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

K. Topsoil: The mineral surface layer of soil that exhibit obliteration of all or much of the original rock structure and must show the following: (1) an accumulation of humified organic matter closely mixed with the mineral fraction and not dominated by properties characteristic of subsurface horizons; (2) has reasonable tilth (biological, chemical and physical properties) to support plant growth; and have two or more of the following:
    a. A bulk density of less than 1.5g/cc installed
    b. Less than 15 percent by weight coarse fragments greater than 2mm
    c. Identifiable structure between clods called peds, no massive structure
    d. No contamination (ie. Toxic weeds, chemicals, heavy metals, construction debris)

L. Wet Soils: Soils that are considered wet will easily be deformed by hand pressure, maintain their shape, and free water will be visible within the pore spaces. The water content at this soil condition is considered at field capacity or wetter.

1.4 QUALITY ASSURANCE

A. Work and materials shall meet the standards of the following references:
    1. International Society of Arboriculture
    2. American Society for Testing Materials (ASTM)
    3. Environmental Protection Agency (EPA)

B. Installer Qualifications: A qualified landscape installer whose work has resulting in successful establishment of exterior plants.
    1. Installer’s Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site who has at least 5 years experience with projects of similar scale and complexity.
    2. The Landscape Contractor shall have experience in the proper and safe transportation and installation of soil material.
    3. The Landscape Contractor shall have adequate supervision, staff, equipment and experience needed to complete a project of this magnitude.
    4. The Landscape Contractor shall prepare and present to the Landscape Architect required soil submittals, and their associated specified test results six months prior to the scheduled soil and plant installation.
    5. The Landscape Contractor shall have at between 3 to 5 years experience in installing designed soil mixes.

C. Soil Mixing Contractor Qualifications:
1. Shall be able to provide soil mixes that meet the specifications within tolerances assigned.
2. Shall be able to produce enough consistently uniform soil material for the project to meet the scheduled demands.
3. The soil mixing contractor shall be engaged at least six months prior to scheduled soil installation to allow for sufficient time for material searches and initial planting mix approval.

D. Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
1. Employ a qualified independent testing and inspection laboratory acceptable to the Landscape Architect and Owner to perform tests and certifications indicated.
2. It is the responsibility of the Contractor to submit material for the soil and compost tests.
3. Tests shall be made in strict compliance with the standards of the Association of Official Analytical Chemists and follow standards from ASTM, EPA, and/or Methods of Soil Analysis, Soil Science Society of America.

1.5 SUBMITTALS

A. Certificates: Provide certificates required by authorities having jurisdiction, including any composted materials containing sewage sludge. Approval as EPA Type 1 “exceptional quality” is required.

B. Sources for Soil Components and Planting Soil Mixes: Submit information identifying sources for all soil components and the contractor responsible for mixing of planting soil mixes.
1. Owner or Landscape Architect shall have the right to reject any soil supplier.
2. Soil mix supplier shall have a minimum of five years experience at supplying custom planting soil mixes.
3. Submit supplier name, address, telephone and fax numbers and contact name.
4. Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project. Indicate quantity and type of material from each supplier.

C. Samples: Planting soils requires a long lead time. Prior to ordering the listed materials, submit representative samples of the same organic batches and soil mixes that will be used to the Soil Scientist for selection and approval. Do not order materials until the Owner’s approval has been obtained. Schedule at least 4 months for soil ingredient search and initial submittal approval. Delivered materials shall closely match the approved samples.
1. Organic amendment: duplicate samples of 1 quart.
2. Soil Mix: duplicate samples of 1 quart for each soil layer after mixing organic material and soil. The Soil Mix shall match the material being placed as closely as possible.

D. Analysis and Testing of Materials: For each type of packaged material required for the work of this Section, provide manufacturer’s certified analysis. For all other materials, provide complete analysis by a recognized laboratory made in strict compliance with the standards and procedures of the following:
1. American Society of Testing Materials (ASTM)
2. American Society of Agronomy
3. Soil Science Society of America
4. Association of Official Agricultural Chemists.

1.6 SOURCE QUALITY CONTROL

A. Testing Intervals for Organic Amendments, Planting Soil Mixes and Subgrade: Testing is required at the following intervals:
   1. Testing of the organic compost material: Test certificates required for producers of municipal yard waste composts or composted biosolids are described within Section 1.5 and shall follow criteria listed within Part B of this section.
   2. After test results for the composted organic material have been accepted the Contractor shall create sample soil mixes for each of the soil layers for the planting soil mix and perform tests described within Part B of this section.
   3. Permeability of the subgrade shall be tested for at least three locations within each defined planting area. Landscape Architect will specify locations and numbers of tests based on the complexity of each planting area.
   4. During the placement of planting soils, test every 1000 cubic yards (or one test for every planting area) of planting soil mix delivered to the job site. Tests shall be for soil mix quality assurance to maintain adherence to particle size distribution, pH, organic matter, salts, and Ammonium. Report organic matter content on a percent by weight basis. Testing applies to all soil layers of the Soil Profile (S2, S3).
   5. Planting Soil In-place Density Test Intervals:
      a. For general planting soils, random penetration resistance testing shall be done at approximately one probe for every 100 ft2 of installed designed planting soil for S2 – S3 layer installation interval and at the completed (S2-S3) soil profile installation interval to track zones of compaction in excess of the specifications.
      b. For soils prescribed under sidewalks, density testing shall be completed using either ASTM D1556 or ASTM D6938-07b for at least four tests of surface soil density per sidewalk installation section.

B. Test Procedures and Reporting: Submit certified report for each test required.
   1. Compost: Analyses of composted organic materials, including composted biosolids, are required prior to initial soil mix acceptance. Analyses shall include all tests specified below and meet the criteria listed in Part 2 of this section.
      a. Maturity index either by Solvita, Dewar Self Heating or CO2 evolution sometimes called respirometry.
      b. Reaction in 1:1 water
      c. Carbon/Nitrogen ratio
      d. Foreign Material on a dry weight basis
      e. Organic Mater percent on a dry weight basis
      f. Ammonium-N using an extract method
      g. Salinity using a 1:1 water paste method
      h. Basic Nutrient content of macro nutrients (P, K, Ca, Mg)
      i. If the compost material contains any biosolids, heavy metals must be tested to meet EPA Chapter 503 and/or Pennsylvania Department of Environmental Protection levels for human use.
   2. Soil Mixes and Topsoil: Testing shall be performed and reported for particle size requiring percent of gravel (>2.0 mm), very coarse sand (2.0 – 1.0 mm), coarse sand (1.0 – 0.5 mm), medium sand (0.5 – 0.25 mm), fine sand (0.25 – 0.10 mm), very fine sand (0.10 – 0.05 mm), silt (0.05 – 0.002 mm) and clay (< 0.002 mm). Saturated conductivity, bulk density, pH, total porosity, salt content, Ammonium content and organic matter percentage on a dry weight basis shall also be tested.
      a. Particle size distribution by ASTM F1632-03 for all soil layers and topsoil. Fines passing the #270 sieve are to be measured using the hydrometer method as outlined in ASTM F1632. If any alternate method is used such as ASTM D422, the results still must be reported at the specified particle size breaks listed below or by plotting as a particle size distribution curve on a five cycle semi-log graph.

b. Organic matter content by ASTM F 1647-02a, commonly known as loss on ignition.
c. Salts and Ammonium test using Woods End Research Laboratory # 104 Soluble Ion Test or 1:2 soil/water extract test as specified in Methods of Soil Analysis, Part 3 and must be tested and made available to the Landscape Architect at least two weeks before planned soil installation.
d. Plant available Phosphorous, Potassium and Cation Exchange Capacity tested for the S1 Planting Soil Mix ONLY.
e. Soil moisture testing by gravimetric oven dry method as described in Soil Science Society of America, Methods of Soil Analysis, Part 1, 1986.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.

B. Sequence deliveries to avoid delay. On-site storage space is permissible only with written notice from Owner. Deliver soil materials only after preparations for placement of planting soil have been completed.

C. Prohibit vehicular and pedestrian traffic on or around stockpiled planting soil.

D. Soil that is to be stockpiled longer than two weeks, whether on or off site, shall not be placed in mounds greater than six feet high. If soil stockpiles greater than six feet high are to be stored for more than two weeks, the contractor shall break down and disperse soil so that mounds do not exceed the six-foot height restriction or thoroughly mix the stockpile once a month.

E. Vehicular access to the site is restricted. Prior to construction the Contractor shall submit for approval a plan showing proposed routing for deliveries and site access which shall include, but not limited to equipment movements and staging locations

F. Soil materials shall be covered at least two weeks prior to installation to prevent excess moisture from saturating the soil stockpile. Test for the moisture content of the soil mix using the gravimetric oven dry method as described in Soil Science Society of America, Methods of Soil Analysis, Part 1, 1986 at least two days prior to soil installation.

G. Soil materials shall not be handled or hauled, placed or compacted when it is wet, as after precipitation, nor when frozen. Soil shall be handled only when the moisture content is less than 8 percent by volume.

H. The planting soil shall be mixed in a ball mill or tub mill fitted with proper screening and paddles. Windrowing the materials is not acceptable, as it does not produce uniform mixing of the components.

1.8 ACCEPTANCE AND MAINTENANCE

A. Soil Installation Acceptance: Notify the soil scientist at least 10 days in advance of date of soil placement. Inspection of the soil installation shall take place during placement of the S3 layer while some of the subgrade is visible and another inspection during the placement of the S2 layer before placement of the S1 layer. Final inspection shall take place during S1 installation.

B. Partial Acceptance: Acceptance of partial areas or portions of the total work may be granted at the option of the Landscape Architect only if the area to be inspected for acceptance is large, well defined and easily described. The Landscape Architect is not obligated to provide partial acceptance of the work.

C. Final Acceptance: Final acceptance shall be defined as the date after which the Landscape Architect and Soil Scientist determine that all work, including Punch List items has been satisfactorily completed.

PART 2 - PRODUCTS

2.1 SOIL LAYERS (HORIZONS):

A. General
1. All plant mix material shall fulfill the requirements as specified and be tested to confirm the specified characteristics.
2. Samples of individual components of plant mixes in addition to blended plant mixes including mulch materials shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Include verification testing of on site sub soils. Comply with specific materials requirements specified.
    a. No base component material or soil components for plant soil mixes shall be used until certified test reports by an approved agricultural chemist have been received and approved by the Landscape Architect and Soil Scientist.
    b. If necessary, testing of the soil material components may be requested by the Soil Scientist to facilitate approval of the plant soil mix.
    c. As necessary, make any and all plant soil mix amendments and resubmit test reports indicating amendments until approved.
3. The Landscape Architect and Soil Scientist may request additional testing by the Contractor for confirmation of mix quality and/or plant soil mix amendments at any time until completion.

B. Suppliers:
1. In the event that any of the soil materials are not available from the supplier or are not in compliance with specifications herein, the Contractor shall obtain material from other suppliers and conduct tests specified herein to provide materials in compliance with these specifications.
2. The Landscape Architect shall be notified of all soil mix substitutions or problems with the planting soil supply in order to assist with a smooth delivery and installation.

C. Planting Soils:
1. Soil layer (S3): Planting Soil Drainage Layer consisting of a 6-inch layer of coarse sand.
    a. Soil reaction with a pH between 4.5 – 7.0.
    b. An estimated permeability of 20 - 25 cm/hour.
    c. There shall be no visible organic material present in this layer.
    d. Particle size distribution shall be:

S3 Soil Layer Particle Size Distribution

Particle Size Class	Passing Sieve No	Range in Percent Passing ASTM F 1632-03
fine gravel	10	95 – 100
very coarse sand	18	80 – 95
coarse sand	35	60 - 80
medium sand	60	10 – 40
fine sand	140	8 – 15
very fine sand	270	3 – 10
silt*		2 – 6
clay*		0 – 4
Organic Matter %	ASTM F 1647-02a	<0.25
pH	1:1 Water	4.5 – 7.0

*determined by hydrometer method in ASTM F1632-03.

2. Soil layer (S2): A variable thickness layer of sand to loamy sand of a maximum of 30 inches. The thickness of the S2 is dependent on the soil profiles for individual planting areas, underground obstructions and transition areas.
   a. The soil specifications shall be that the minimum infiltration rate stays above 15 cm/hour (6 in/hr) after installation.
   b. There should be no coarse fragments over 2.5 cm (1 in.) in size. The soil shall have soil moisture content less than 8% by weight for installation.
   c. The S2 layer shall have a uniformly increasing with depth, penetration resistance of < 200 lbs/in2 after installation.
   d. The particle size distribution shall be:

S2 Soil Layer Particle Size Distribution

Particle Size Class	Passing Sieve No	Range in Percent Passing ASTM F 1632-03
fine gravel	10	95 – 100
very coarse sand	18	90 – 100
coarse sand	35	65 – 85
medium sand	60	30 – 40
fine sand	140	15 – 25
very fine sand	270	8 – 14
silt*		5 – 8
clay*		3 – 6
Organic Matter %	ASTM F 1647-02a	<1
pH	1:1 Water	5.5 – 6.5
EC	1:1 paste	1.5 dS/m

*determined by hydrometer method in ASTM F1632-03.

3. Soil layer (S1): Planting Soil Surface layer. Consisting of a layer of sand to loamy sand (S2) amended with organic matter. (must be tested to meet specs after compost is approved and added)

a. The soil specifications shall be that the minimum infiltration rate for planting soil areas stays above 5 cm/hour (2 in/hr) after installation.
b. The soil shall have soil moisture content less than 8% by weight for installation.
c. The S1 layer shall have a uniformly increasing with depth, penetration resistance of < 120 lbs/in2 after installation.
d. The particle size distribution shall be:

S1 Soil Layer Particle Size Distribution

Particle Size Class	**Passing Sieve No**	**Range in Percent Passing** ASTM F 1632-03
fine gravel	10	95 – 100
very coarse sand	18	90 – 100
coarse sand	35	65 – 85
medium sand	60	30 – 40
fine sand	140	15 – 25
very fine sand	270	8 – 14
silt*		5 – 8
clay*		3 – 6
Organic Matter %	ASTM F 1647-02a	2 – 4%
pH	1:1 water	5.5 – 6.5
EC	1:1 paste	1.5 dS/m
Phosphorous (P)	extract	20 – 100 ppm
Potassium (K)	extract	200 – 600 ppm
Cation Exchange (CEC)	Extract	>10 Meq/100g

*determined by hydrometer method in ASTM F1632-03.

D. Organic Amendment:
1. Composted Biosolid and municipal yard waste compost producers shall provide the heavy metal certificate of the material delivered as per EPA and PADEP standards. Composted organic matter shall have the following criteria:

Criteria	**Test Method**	**Acceptable Range**
Type		Brewer's waste, or leaf mulches are also acceptable. Composted municipal waste (chipped, shredded and screened wood, leaves, bark, etc.) alone is not acceptable unless it meets all of the criteria noted
Carbon/Nitrogen Ratio		11:1 – 22:1
Degree of Maturity	Dewer Self Heating or	VI – V
	Solvita Maturity Index or	6 – 8
	CO_2 Evolution	1.2 % C/day
Foreign Material	Dry wt.	< 1" dia. And < 2% (of total)
Organic Matter %	Dry wt.	25 – 55%
Reaction	1:1 water	5.5 – 8.0
Ammonium	extract	< 200 ppm

Salinity	1:1 paste	< 1.5 dS/m
Nutrient Content	extract	Contains some nitrogen, phosphorus, potassium, calcium, magnesium, sodium and micronutrients including iron, copper, boron, and manganese. Nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism.
Heavy Metals	extract	Concentrations of zinc, mercury, cadmium, lead, nickel, chromium, and copper must be below EPA and the Pennsylvania Department of Environmental Protection standards for biosolid applications to soils with human activity.

E. Planting Soil Mix Equivalency Table:
1. The mix ratios are rough estimates based on usual components found in the area and their physical properties. Slight adjustments to the mix may be needed to achieve the required planting soil properties.

Layer Designation	**Base Material or Equivalent**	**Second Soil Mix Component**	**Third Soil Mix Component**	**Mix Ratio (Volume)**
S3 Layer	US Silica USGA straight sand or Masonry Sand	None	None	None
S2 Layer	US Silica 80/20 Turf Mix	None	None	None
	Approved S3 material	sandy loam*	None	3:1
		sandy clay loam*	None	5:1
		loam*	None	4:1
S1 Layer	S2 planting soil mix	Approved Compost	None	4:1

2.2 SOIL PROFILES

A. Sand Based Structural Soil Profile: This planting soil profile consists of two soil horizons (See Soil Profile Detail Drawings). This soil profile shall be areas as noted on the drawings. A S2 layer of variable thickness averaging around 24 inches, but thinned for subsurface utilities and thickened for larger B&B root balls to achieve final grade. The basis for the S2 layer is the loamy sand specified in Part 2.1. The drainage layer (S3) is coarse sand specified in Part 2.1 of this section.

PART 3 - EXECUTION

3.1 COORDINATION

A. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Owner in writing of all deficiencies and conditions detrimental to the proper completion of this work.

Beginning work means the Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Owner.

B. Planting Soil Preparation: Examine soil and remove foreign materials, stones over 1", and organic debris over 2" in length. Mix-in amendments as required by tests and as approved by the Owner. All preparation and mixing shall be accomplished when the soil moisture content is less than 8 percent by volume.

C. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

3.2 EXCAVATION AND SCARIFICATION

A. Excavation of the soils shall be accomplished to a depths noted for each soil profile area. All construction debris shall be removed from the planting areas prior to placement of the soil layers. Care shall be taken to avoid working the soil when it has 8 percent moisture content or above.
   1. Excavation Depths: (of the subgrade below final grade)
      a. Tree Planting Areas shall be excavated to depth below final grade as shown on drawings.
   2. Subgrade pitch: The subgrade shall be pitched toward the underdrainage with an average around 1.5 percent or about 2.0 inches fall per 10 feet.

B. Scarification of the Subgrade: After the specified engineering compaction for the subgrade is accomplished, scarification must loosen the compacted surface of the subgrade following final rough grade to a depth of 4 to 6 inches prior to the designed soil placement. The subgrade shall have a permeability of not less than 0.1 inches/hour. Determine permeability of the subgrade using a single ring infiltrometer method after it has been scarified. If infiltration of the subgrade is below 0.1 in/hr, scarify perpendicular to previous scarification to a depth of 6 to 8 inches and retest for infiltration.

3.3 MIXING OF TOPSOIL

A. The planting soil shall be mixed in a ball mill or tub mill fitted with proper screening and paddles. Windrowing the materials is not acceptable, as it does not produce uniform mixing of the components.

B. Mixing of the compost for the S1 layer (topsoil) shall be accomplished in the same manner as the other mixing procedures. The compost shall be moist, but not overly wet. Compost shall not be so wet as to have water squeezed out by hand or so dry as to be easily blown by wind.

3.4 PLACEMENT OF SOIL LAYERS (HORIZONS)

A. Examination of Subgrade: The subgrade shall be examined by the Contractor prior to the start of soil placement and planting. Any deficiencies shall be noted and related to the Owner in writing prior to acceptance of the subgrade by the Landscape Contractor:

B. Planting Soil Placement:
   1. For areas designated Sand Based Structural Soil Profile (See Drawings):

a. Scarify the subgrade to a depth of 4 to 6 inches. Run tests in several randomly selected areas per work unit for infiltration requirement.
b. Place the S3 drainage layer in one 6 inch lift over the scarified subgrade that is correctly pitched to the underdrainage piping. Compaction of this lift shall consist of light tamping by the installers foot traffic. No mechanical compaction shall be allowed except where otherwise noted.
c. Place 24 inches of S2 material in 6 inch lifts. Compact each lift to 90 percent of Standard Proctor below optimum moisture. DO NOT compact soils above optimum moisture content.
d. Scarify each lift surface before applying additional lifts to a depth of 2-3 inches. The final lift shall be compacted to 90% and shall not be scarified.

2. Complete all hardscape construction after installation of the S2 layer and Clean Subsoil has occurred.
   a. Limit all traffic during construction to areas designated for hardscape placement.
   b. After hardscape construction is complete, the S2 layer and Clean Subsoil shall be scarified to loosen compacted areas adjacent to where construction occurred. Penetration resistance shall not exceed 200 lbs/ft2 except where noted. Resistance shall be uniformly increasing with depth.
   c. The scarification shall be such that care is taken not to damage the hardscape.
   d. The depth of the scarification shall be 2 to 3 inches. Deeper loosening may be required if compaction is extensive. Test with cone penetrometer.
   e. Scarify any other areas that have been compacted prior to S1 layer or Topsoil placement.

CONSTRUCTION NOTE: For all utility boxes and structures that will be placed completely within the designed soil shall require compacted pedestals to support the structures.

3.5 FIELD QUALITY CONTROL

A. In-place designed soil testing:
   1. General planting soil installation shall be tested using a cone penetrometer or equivalent for one point every 100 ft2 at an interval for S2 layer installation and complete soil profile installation.
   2. In-place Density Tests for soils prescribed under sidewalks and pervious parking surfaces shall be conducted for at least three tests of surface soil density per segment as noted on the drawings. The surface that is to support pavement construction is to be tested. Density testing shall conform to ASTM standards using either ASTM D1556 or ASTM D6938-07b and shall be at 90% of Standard Proctor measured at below optimum moisture content (Do not compact planting soils at moisture contents above the “Optimum” line).

3.6 PROTECTION AND REPAIRS

A. General:
   1. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials. Landscape contractor shall be the only personnel allowed on areas where planting soil has been installed.
   2. Within the installation warranty period repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compacted due to subsequent construction operations or weather conditions.

3. Scarify or remove and replace material to a depth as directed by the Owner; reshape and re-compact by only hand tamping at the prescribed moisture content.
4. Where settling occurs, before sidewalk construction and final soil installation acceptance, backfill with additional approved material, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.

3.7 POST INSTALLATION MAINTENANCE

A. Where settling occurs, backfill with additional approved material, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.
   1. Any post installation changes or amendments to previously approved soils without the Landscape Architect's consent are the responsibility of the Owner.

B. Fertilization of planting areas shall be handled after establishment after soil tests have been taken to determine the optimum fertilizer rates.

C. The following items are the responsibility of the Owner after the Guarantee Period to ensure the sustainability of the designed soil and plants for the life of site.
   1. After one year, collect soil samples in each of the various soil areas and submit them for laboratory testing for fertilizer and liming recommendations.
   2. Soil and planting area shall be sampled separately, but similar areas can be grouped. For example, areas of designed soil in turf areas, planting beds (flower and shrub), and turf areas of pre-existing plantings shall to be sampled and tested separately. Fertilization and liming needs to be tailored to each area for maximum effect and to reduce over fertilizing and liming and possible contamination of ground water and runoff.
   3. Repeat soil sampling for these areas every two years after first sampling and fertilize and lime to test recommendations.

END OF SECTION 329113

SECTION 329115 – SOIL PREPARATION AND MIXES

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. Work included: provide labor, materials and equipment necessary to complete the work of this section, including but not limited to the following:
   1. Furnishing and testing all soils and plant mix materials, including salvaged on-site topsoil, off site borrow materials, amendment materials, manufactured growing media and other component materials for approved use in planting mixes. These consist of:
      a. A Base Mix comprised of loam, sand, organic matter and soil amendment materials.
      b. Various Planting Mixes comprised of a Base Mix, additional organic matter and soil amendment materials.
   2. Preparing transition zone and subgrade at planting areas, including areas over structure.
      a. Preparation shall include amending and mixing planting soil with existing on-site soil to the depths indicated for transition zones of each area.
      b. Preparation of subgrade shall include verification and scarification of the subgrade prior to placement of planting soil mixes.
   3. Placing, spreading, and fine grading pre-mixed planting soil material of the type(s) indicated for plant areas, including areas over structural slabs.
      a. For areas over structural slabs: Inspect existing conditions and provide protection measures for structural deck, waterproofing, drainage and EPS fill.
   4. Testing installed planting soil mixes and Growing Media to ensure compaction rates as specified.
   5. Protecting all stock piles and plant mix installations with approved means until substantial completion.
   6. Supplying and installing erosion control material(s).
   7. Protection of finished paving, light standards, utility or other finished work over the area of construction concurrent with any and all construction operations.

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 04 Section ‘Site Stone Masonry’
   3. Division 32 Section ‘Crushed Stone Paving’
   4. Division 32 Section ‘Salvaged Boulders’
   5. Division 32 Section ‘Concrete Paving’
   6. Division 32 Section 'Unit Paving’
   7. Division 32 Section 'Metal Edging’
   8. Division 32 Section 'Turf and Grasses
   9. Division 32 Section 'Exterior Planting’

1.3 REFERENCE STANDARDS

A. Agricultural Chemist: Qualified, experienced public or private soils testing laboratory, capable of providing test results as specified, and approved by the Contracting Officer.

B. ASTM: American Society of Testing Materials
   1. ASTM D422-63 Particle size distribution
   2. ASTM D5084: Saturated Hydraulic Conductivity (performed on material compacted to 85% proctor)
   3. Any other test criteria as specified or required by other references.

C. USDA: United States Department of Agriculture

D. AASHTO: American Association of State Highway and Transportation Officials

E. AOAC: Association of Official Agricultural Chemists

F. SSSA: Soil Science of America, Methods of Soil Analysis

G. TMECC: Test Methods for the Examination of Composting and Compost

H. NER493: Recommended Soil Testing Procedures for the Northeastern U.S.

1.4 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Growing Medium: A manufactured mix of mineral materials, stabilizing organic amendments and stabilized aggregates to provide a mixture that promotes good growing conditions for the plants specified.

C. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce planting soil.

D. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments as specified.

E. Soil: A naturally occurring material of differing horizons, of which the uppermost is often used as a component in a soil mix or growing medium.

F. Topsoil: Natural surface-soil or prepared planting mix layer containing organic matter and sand, silt and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil materials including, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil or non-specified materials.

G. Transition Mix: Imported topsoil / loam or manufactured soil, mixed with soil amendments as specified, such as sand that is homogeneously blended as specified to create a conversion layer between the existing native soil and imported planting soil.

H. Base Mix Composite: Homogenously blended mix of sand and loam component materials which is then used for mixing with organic matter to create planting soils.

I. Salvaged On-site Topsoil: Stripped native loam removed within the limits of work, but outside of the “Tree Protection Areas”, to its entire natural depth.

J. Subgrade: Surface or elevation of subsoil remaining after completing excavation or backfill immediately beneath planting soil or lightweight fill material, that is integrated with Specified Soil or Growing Media by tilling in a layer of Transition Mix.

K. Debris: Elements including, but not limited to, concrete, concrete masonry, wood, excavated rock and rock fragments, rubble, overburden soils, abandoned utility structures, trash, refuse and litter.

1.5 ACTION SUBMITTALS

A. Product Data: Submit technical descriptive data for each manufactured or packaged product of this Section. Include manufacturer's product testing and analysis and installation instructions for manufactured or processed items and materials.
   1. Organic matter: Include source, guaranteed analysis, and weight for packaged material.
   2. Ground Limestone: Include guaranteed analysis, and weight for packaged material.
   3. Fertilizer: Include guaranteed analysis.
   4. Systemic Herbicide: Include complete information including manufacturer’s recommendations for use.
   5. Soil stabilization materials.

B. Mix or Amended Soil Suppliers
   1. Locations: Submit locations of material sources. Submit location of mixing sites, including off site mixing of plant mix or soil amendment components.
   2. Landscape Architect shall have the right to reject any soil supplier or salvaged on-site topsoil.
   3. Soil Mix supplier shall have a minimum of five (5) years experience at supplying custom planting soil mixes.
   4. Submit supplier name, address, email, telephone, and fax email numbers and contact name.
   5. Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project and within the limitations of the Project Schedule.
   6. Statement(s) of Qualifications: Submit within 45 days of notice to proceed to confirm qualifications.
   7. Submit written statement from proposed agricultural chemist or laboratory that required tests can be performed in accordance with the specifications, comply with all formats and classification specified herein.

C. Test reports – Soil, Soil Amendment and Plant Mix Component Analysis: The Contractor shall submit representative samples of sand, salvaged on-site topsoil, organic material components and all plant mix materials and which are intended to be used for planting soil mixes and final mixes, to an independent Soil and Plant Testing Laboratory acceptable to the Landscape Architect.
   1. All tests shall be performed in accordance with the current standards of the Association of Official Agriculture Chemists.
   2. All reports shall be submitted to the Landscape Architect for approval.
   3. Samples of all soil materials to be brought to the site must be approved before delivery.
   4. Deficiencies in the soils shall be corrected by the Contractor, as directed by the Landscape Architect after review of the testing agency report.

5. Each report must comply with the formats and classifications specified herein. Reports not providing like analysis format will be rejected. Each report shall include the following as a minimum and such other information required specific to material tested:
    a. Date issued.
    b. Project Title and names of Contractor and supplier.
    c. Testing laboratory name, address and telephone number, and name(s), as applicable, of each field and laboratory inspector.
    d. Date, place, and time of sampling or test, with record of temperature and weather conditions.
    e. Location of material source.
    f. Type of test.
    g. Results of tests including identification of deviations from acceptable ranges.
    h. Recommendations for soil additives, including organic and inorganic soil amendments, necessary to accomplish particular planting objectives noted.
6. Certified reports on analyses from producers of composted organic materials are required, additional tests are required when sources are changed.
7. Although the report(s) are to contain the laboratory's comments or recommendations to the Landscape Architects regarding amendment requirements or procedures, the report shall not be interpreted to prescribe or dictate procedures or quantities of soil materials for the work of this Contract without the Landscape Architect’s written permission.
8. Tests to be conducted for each component and Planting Mix are listed in Part 2 of this Specification.
9. Testing Agencies: The following firms are acceptable testing agencies for the various components.
    a. Wallace Laboratories, 365 Coral Circle, El Segundo, CA 80245; Telephone: 310-615-0116.
    b. Approved Equal.

D. All samples to be submitted to the Landscape Architect for approval:
1. Organic Compost Material, each source, 5 lb. packaged.
2. Sand, each source, 5 lb packaged.
3. Loam Topsoil, each source, 5 lb packaged.
4. Base Mix Composite, each source, 5 lb. packaged.
5. Planting Soil Mix, each specified, 5 lb. packaged.
6. Soil Stabilization Material, each type: 12" x 12" piece.
7. Stakes for use with Soil Stabilization Material, One sample.

E. Equipment Data: Submit descriptive information with wheel load data for each proposed item of equipment to be used for execution of earthwork of this Contract. Equipment Data will be evaluated for conformance to site restriction of use.

F. Statement(s) of Qualifications: Submit within 45 days of notice to proceed.

G. Schedule and Protection Plan: Submit a detailed plan for scheduling and sequencing of all contract work and for protection of soil mixes and other completed work including coordination with contractors requiring access through the site. Indicate with schedules and plans the utilization of soil mix and subsoil protection measures over the surface area of plant bed installations, until Substantial Completion. Indicate with schedules and plans the utilization of finished work protection measures (wooden protection boards or other approved methods) over the work area of construction operations concurrent with all construction operations until substantial completion.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in “Preconstruction Testing” Article.

C. Field quality-control reports.

D. Certificates:
1. Submit certified analysis for each soil treatment, amendment, and fertilizer material specified and as used. Include guaranteed analysis and weight for packaged materials.

E. Equipment Data: Submit descriptive information with wheel load data for each proposed item of equipment to be used for execution of earthwork of this Contract. Equipment Data will be evaluated for conformance to site restriction of use.

F. Schedule and Protection Plan: Submit a detailed plan for scheduling and sequencing of all contract work and for protection of soil mixes and other completed work including coordination with contractors requiring access through the site. Indicate with schedules and plans the utilization of soil mix and subsoil protection measures over the surface area of plant bed installations, until Substantial Completion. Indicate with schedules and plans the utilization of finished work protection measures (wooden protection boards or other approved methods) over the work area of construction operations concurrent with all construction operations until substantial completion.

G. Settlement Methodology: Submit a plan with a schedule describing the proposed method intended for settling installed work.

1.7 QUALITY ASSURANCE

A. The Base Mix Composite and each Composite Planting Mix are comprised of various components including loam, sand, organic matter and other soil amendment materials. Each individual component must meet the specification herein and be verified by testing as specified herein, prior to manufacturing the specified Planting Mixes.

B. The specified Planting Mixes are comprised of the Base Mix Composite with additional organic matter and soil amendment materials. Each Planting Mix must meet the specification herein and be verified by testing as specified herein, prior to delivery to the site.

C. No component or composite mix will be accepted unless it meets all submittal, testing and certification requirements including testing and certification report format specified herein.

D. Inspections and Testing
1. Sand, soil, compost, and other material testing and soil mix testing required in this Section or additionally required by the Landscape Architect shall be furnished and paid for by Contractor.
2. The Landscape Architect reserves the right to take and analyze at any time such additional samples of materials as deemed necessary for verification of conformance to specification requirements. Contractor shall furnish samples for this purpose upon request and shall perform testing as requested.

E. Qualifications

1. The work of this section shall be performed by a company which specializes in the type of work required for this Project, certified in writing by manufacturer, with a minimum of five (5) years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary tasks.
   a. Work shall be performed in compliance with Owner's insurance underwriters' requirements.
2. Installation and maintenance foreman on the job shall be competent English-speaking supervisor(s), with a minimum of five (5) years experience in soil installation and general landscape construction and maintenance. Perform work with personnel totally familiar with planting soil preparation and lawn and planting installations under the supervision of a foreman experienced with landscape work.
   a. Notify Landscape Architect of the name and phone number of the foreman five (5) business days in advance of the first day of each phase of soil placement including transition soil layer and all Planting Soil Mixes.
3. Testing Laboratory: Experienced person or persons employed by public or private soils testing laboratory, qualified and capable of performing tests, making soil recommendations, and issuing reports as specified. The Testing Laboratory shall be as approved by the Landscape Architect.
4. It shall be the responsibility of the Contractor to see that the specifications are being adhered to. Failure of the Landscape Architect to immediately reject unsatisfactory workmanship or to notify the Contractor of his/her deviation from the specifications shall not relieve the Contractor of his/her responsibility to repair and/or replace unsatisfactory work.

F. Arrange a pre-construction meeting between Landscape Architect, Contractor, and Testing Laboratory representative. Such meeting shall seek to review the soil testing and soil work schedule, phasing, review of specifications and construction procedures. Inform the Landscape Architect five (5) business days in advance of the scheduled meeting time.

G. Pre-Installation Conferences: Person(s) responsible for soil preparation and mixes of this Section shall attend Pre-Installation Conference(s) to coordinate with work of other sections.

1.8 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of government authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials and secure, in advance, any necessary permits.

C. Procure and pay for permits and licenses required for Work.

1.9 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.

1. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.

B. Investigate the conditions of site and public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of this work site. Conform to all governmental regulations in regard to the transportation of materials to, from, and at the job site, and secure in advance such permits as may be necessary.

C. The Contractor shall be responsible for pedestrian and vehicular safety and control within the work site. He/she shall provide the necessary warning devices and ground personnel needed to give safety, warning and protection to persons and vehicular traffic within the area.

D. During site preparation, soil installation and protection, the Contractor shall be responsible for all damage to existing features above and below finished grade (structural decking, waterproofing, drainage, utility lines, irrigation pipes, paving surfaces, existing vegetation, site furnishings) incurred as a result of work operations. Repairs or replacements shall be made to the satisfaction of the Owner.

E. Should the Contractor, in the course of Work, find any discrepancies between Contract Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Owner, it will be Contractor's duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

F. Perform both off-site mixing and on-site soil work only during suitable weather conditions. Do not disc, rototill, or work soil when frozen, excessively wet (as defined by Landscape Architect), or in otherwise unsatisfactory condition.

G. Soil mixes shall not be handled, hauled or placed during rain or wet weather or when near or above the point where maximum compaction will occur (as defined by Landscape Architect).

1.10 SEQUENCING AND SCHEDULING

A. Sequencing and Scheduling: Adjust, relate together and otherwise coordinate work of this Section with work or Project and all other Sections of Project Specifications.

B. Sequence work of soil mix placement to allow for adequate settlement and redressing prior to installation of plant material.

C. Coordinate earthwork, soil preparation and seeding work. Do not allow planting soil mix to be exposed for longer than seven (7) days without temporary or permanent cover, or other erosion control cover.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials to the location where soils are to be mixed, in unopened bags or containers, each bearing the name, guarantee, and trademark or the producer, material composition, manufacturer’s certified analysis, and the weight or the material. Retain packages for the Landscape Architect.

B. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, and theft.

C. Bulk Materials: 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.

D. Soil or amendment materials stored on site temporarily in stockpiles prior to placement shall be protected from intrusion of contaminants and erosion. All temporary storage means and methods shall be approved by the Landscape Architect.

E. After mixing, soil mixtures shall be covered with a tarpaulin until time of actual use and protected from contamination or erosion.

1.12 GUARANTEE

A. In addition to the specific guarantee requirements of the General Conditions and Supplementary General conditions, the Contractor shall obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities, which the Contractor may have by law or other provisions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED PLANTING MIXES: COMPONENT MATERIALS

A. General
   1. All planting mix materials shall fulfill the requirements for new plant mixes as specified.
   2. Samples of individual components of planting mixes and blended planting mixes shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Include verification testing of on-site sub soils. Comply with specific materials requirements specified.
      a. Perform tests as specified herein, see Article 1.5 Submittals. Failure to include any of the criteria will be sufficient cause for rejection of the test reports.
      b. No base component or soil components for plant mixes shall be used until certified test reports by an approved agricultural chemist have been received and approved by the Landscape Architect.
      c. As necessary, make any and all soil mix amendments and resubmit tests reports indicating amendments including type and amount until approved.
   3. The Landscape Architect may request additional testing by Contractor for confirmation of mix quality and compliance to specification at any time until completion.
   4. Physical Analysis (Soil Texture) test results must be submitted for percent passing as well as percent retained for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.

B. Base Mix – Sand Component
   1. The sand shall be a clean, sharp, natural silica or limestone sand that has been suitably washed and classified (sieved). Suitable sands may be referred to in commerce as a uniform, ASTM-33 concrete sand (preferred) or a coarse mason's sand or a coarse U.S.G.A. root zone sand. The selected sand must meet the following U.S.D.A. particle

size distribution as well as the other gradation characteristics listed in Part C when tested in accordance with the ASTM D-422 using U.S.D.A. particle size classifications.

2. The allowable particle size distribution is as follows:

U.S.D.A. Particle Class	Particle Size (mm)	Percent Retained
Gravel	>3.34	0 - 3
Fine Gravel	2.00 – 3.34	0 - 10 Not More than 12% combined Gravel + Fine Gravel
VeryCoarse Sand	1.00 – 2.00	10 – 25
Coarse Sand	0.50 – 1.00	20 – 40
Medium Sand	0.25 – 0.50	20 – 40
Fine Sand	0.10 – 0.25	0 – 10
Very Fine Sand	0.05 – 0.10	0 – 10
Silt + Clay	< 0.05	0 – 10

3. Sand sieve test reports must be submitted for percent (%) retained as well as for percent (%) passing for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.
4. Other Gradation Characteristics must fall within the limits specified below:
   a. Fineness Modulus (FM) - 2.5 to 3.1.
   b. Coefficient of Uniformity - 2.5 to 3.5 preferred (< 4.1 acceptable).
5. The sand shall meet the following specifications. Perform the following tests and submit test reports showing the following criteria are met:
   a. The particle size analysis/distribution as defined above.
   b. The pH shall be 5.0 to 7.0.
   c. The soluble salts shall be less than 0.5 mmoh/cm as determined by electrical conductivity of a 1:2 soil/water sample measured in Millimhos per cm.
   d. The organic matter content shall be less than 1.0% as determined by Loss on Ignition; Ash Burn Test, ASTM D 2974-87.
   e. The material drainage rate or saturated hydraulic conductivity (ASTM F1815) shall be greater than 20 inches per hour.
   f. Analysis for levels of toxic elements and compounds including Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Molybdenum, Nickel, Zinc, and PCBs. Test results shall be cited in milligrams per kilogram.

C. Base Mix – Topsoil Component
1. Provide a loamy, friable mineral soil essentially free from heavy or stiff clay lumps, stones, cinders, concrete, brick, roots, sticks brush, litter, plastics, metals, refuse or other deleterious materials in accordance with ASTM D 5286-92.
2. The soil shall be free of herbicides, petroleum-based materials or other substances of a hazardous or toxic nature which may inhibit plant growth.
3. The soil shall be free of noxious weeds, seeds or vegetative parts of weedy plants that cannot be selectively controlled in the planting.
4. The soil shall be taken from the A Horizon of a well-drained site and have a USDA soil texture classification of a Clay Loam or Loam. The topsoil shall have the following particle size distribution:

Particle Name	Size (mm)	Allowable Limit
Gravel	2.00 – 4.75	Less than 5%
Sand	0.05 – 2.00	25 – 40%
Silt	0.002 – 0.05	20 – 50%
Clay	< 0.002	20 – 35%

5. Soil Texture test results must be submitted for percent (%) retained as well as for percent (%) passing for all sieve size. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.
6. The topsoil component shall meet the following specifications. Perform the following tests and submit test reports showing the following criteria are met:
    a. The particle size analysis as defined above.
    b. The pH shall be 5.0 to 7.0.
    c. Cation Exchange Capacity (CEC) per NER493 or NCR221 using the pH 7 ammonium acetate method.
    d. The soluble salts shall be less than 1.5 mmoh/cm as determined by electrical conductivity of a 1:2 soil/water sample measured in Millimhos per cm.
    e. The organic matter content shall be 3.0 to 6.0% as determined by Loss on Ignition; Ash Burn Test, ASTM D 2974-87.
    f. Saturated hydraulic conductivity shall be (ASTM F1815) shall be greater than .5 inches per hour.
    g. Analysis for levels of toxic elements and compounds including Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Molybdenum, Nickel, Zinc, and PCBs. Test results shall be cited in milligrams per kilogram.
7. Off-site (borrow) topsoils meeting the criteria shown above must be used for the Base Mix and their source or location communicated to the Landscape Architect.

D. Base Mix - Organic Amendment
1. The organic amendment shall be stable, mature aerobically composted yard debris (green waste) compost.
    a. Leaf humus compost, manure composts, bio-solids compost, peat, peat-humus and mushroom compost products are not acceptable.
    b. The compost material must meet the requirements of all state and local Composting Regulations and have the following characteristics:
        1) The compost shall be a homogeneous material essentially free of soil clods, lumps, roots and stones.
        2) The compost shall have a man-made foreign material (hard plastics, metal, glass, etc.) content less than 1.5% as material retained on a U.S. Std.No.5 (4 mm) sieve (TMECC 03.06).
        3) The compost shall be screened such that a minimum of 100% passes a US.Std. 3/4” sieve and that no more than 10% passes a U.S. Std. No.10 sieve on a dry weight basis.
        4) The compost shall have a pH of 5.0 to 7.0.
        5) The compost shall have a soluble salts content less than 6.0 millimhos per cm. when determined on a 1:5 compost/water slurry sample measured in Millimhos per cm.
        6) The compost shall have an organic matter content of not less than 40% by weight determined by Loss on Ignition; Ash Burn Test ASTM D2974-87 Method C on material passing a U.S. Std.1/4” sieve.
        7) Ash content shall not exceed 40% as determined by Loss on Ignition.
        8) The compost shall have a carbon to nitrogen (C:N) ratio less than 36:1.
        9) The compost shall have a Solvita® Maturity Index between 6 and 7.
        10) The compost shall have a moisture content of 45% to 65%.
        11) The compost shall have a dry bulk density of 0.17 to 0.35 grams per cubic centimeter (g/cc).
        12) Saturated hydraulic conductivity shall be tested and reported in inches per hour per ASTM F1815.
        13) The compost shall be tested for Nitrate nitrogen, Ammonium nitrogen, Nitrite, Phosphorus, Potassium, Calcium, Magnesium, Iron, Manganese, Zinc, Copper, Boron, Sodium and extractable Aluminum using the SME-DTPA extraction method.

14) The heavy metal content as determined by TMECC 04.06 shall not exceed the following limits:

Element	Concentration Limits (mg/Kg d.w.)
Arsenic	41
Cadmium	39
Chromium	1200
Copper	1500
Lead	300
Mercury	17
Molybdenum	50
Nickel	420
Selenium	36
Zinc	2800

15) Yard waste composts that may contain grass clippings shall be tested for chlopyralid and picloram.
16) The compost shall meet all applicable state regulations based on the feedstock type.
17) All compost testing shall be done in conformance with the U.S. Compost Council's publication "Test Methods for the Examination of Composting and Compost" (TMECC) otherwise specified above.

2.2 MANUFACTURED PLANTING MIXES: BASE MIX PREPARATION

A. Prepare the Base Mix by thoroughly blending the Sand component and the Topsoil Component.
   1. The Base Mix shall have a granular consistency essentially free of soil lumps larger than 1". The topsoil used to make the Base Mix must be pre-screened to achieve a granular consistency essentially free of soil lumps.
   2. Mixing shall be done using equipment designed for soil blending and screening.
   3. The Base Mix shall substantially conform to a mix of 4 parts of the approved Sand and 1 part of the approved Topsoil.

B. Testing of the Base Mix:
   1. Manufacture 20 to 30 cu.yds of Base Mix and compare to a test mix prepared by the soil testing laboratory in the same ratio of 4 parts approved Sand to 1 part approved Topsoil.
   2. Test the manufactured Base Mix and the laboratory test mix for its USDA Soil Texture Analysis with Gravel/Sand Classifications using the same particle size classifications shown for the Sand component report.
   3. If the manufactured Base Mix results do not substantially match the laboratory test mix, manufacture another 20 to 30 cu.yds following the recommendations provided by the soil testing laboratory. Repeat as necessary until the test results substantially match.
   4. The saturated hydraulic conductivity of the Base Mix shall be 3 to 8 inches per hour. The Saturated Bulk Density shall be not more than 114 lbs./cu.ft. Adjust the proportion of the approved Sand and the approved Topsoil in the manufactured Base Mix to meet these criteria.
   5. These test results and criteria, when approved by the Landscape Architect, shall establish the standard to which all subsequent Base Mix tests must conform.

2.3 PLANTING MIXES

A. Adequate quantities of planting mix materials shall be provided to attain, after compaction and natural settlement, all design finish grades. Verify quantities for placement as specified to suit site conditions.

B. Uniformly mix components using a mechanical soil blender designed for such purpose as specified for each Planting Mix Type.
   1. Mixing of Base Mix and Organic Amendment (Compost): Add compost as recommended by the testing laboratory to achieve the specified organic matter content by Planting Mix type. Other amendments shall not be added to Planting Mixes unless approved by the Landscape Architect and additional tests have been conducted to verify type and quantity of amendment.

C. Testing of Planting Mixes:
   1. Perform initial tests to confirm compliance with the Planting Mix organic matter content specifications. These test results, when approved, will establish the standard to which all other test results must conform.

D. Planting Mix Types: Provide the following Planting Mix types at the locations and depths as indicated on the Contract Drawings. Mix ratio volumes, will be established upon completion of the testing for the individual components of the Planting Mixes. The controlling factor will be the percent (%) organic matter by weight as specified for each Planting Mix, percentage of sand content, as well as the soil pH. Note that volume ratios of the Base Mix and the Organic Amendment (compost) components will be, in large part, determined by the organic matter content of the compost. Follow the recommendations on mix design provided by the soil testing laboratory to achieve the target organic matter content for all Planting Mixes.
   1. Planting Soil Mix for Tree, Shrub, and Perennial Plantings:
      a. Base Mix: 60%
      b. Organic Amendment: 40%
      c. Goal for percent (%) of Organic Material in Mix (by weight): 6-8%
      d. Soil depth: As indicated on drawings.
      e. Additional Sand Content: 0%
   2. Planting Soil Mix for Turfgrass Plantings:
      a. Base Mix: 70%
      b. Organic Amendment: 20%
      c. Goal for percent (%) of Organic Material in Mix (by weight) 3-4%
      d. Soil depth: As indicated on drawings.
      e. Additional Sand Content: 10%

E. Testing of Planting Soil Mixes (all mixes): Take one (1) composite sample upon arrival to the site from each 500 cubic yards or as required by the Landscape Architect for testing each type of Planting Mix and test the following by way of a Licensed vendor to provide certified results for the following tests:
   1. Particle size analysis: Use sieve sizes as specified for the Base Mix.
   2. Organic matter content as per Loss on Ignition; Ash Burn Test ASTM D2974-87.
   3. Nutrient Analysis to include Nitrate nitrogen, Ammonium nitrogen, Nitrite, Phosphorus, Potassium, Calcium, Magnesium, Iron, Manganese, Zinc, Copper, Boron and Extractable Aluminum. Request testing laboratory recommendations for fertilizer requirements for plant types being used.
   4. Soil pH and Buffer pH.
   5. Carbon to Nitrogen Ration (C:N Ratio).
   6. Cation Exchange Capacity (CEC) per NER493 or NCR 221 using the pH7 ammonium acetate method.

7. Soluble salt content shall be less than 2.5 mmoh/cm as determined by electrical conductivity of a 1:2 soil/water sample measured in Millimhos per cm.
8. Saturated hydraulic conductivity shall be tested and reported in inches per hour per ASTM F1815.
9. Analysis for levels of toxic elements and compounds including Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Molybdenum, Nickel, Zinc, and PCBs. Test results shall be cited in milligrams per kilogram.
10. California Bearing Ratio test results for each Structural Soil sample compacted to peak standard density. The soaked CBR shall equal or exceed a value of 50.
11. Measured dry-weight percentage of stone in the Structural Soil mixture.
12. Proctor Test.

F. Stockpiling
1. General: Stockpiling on-site, off-site, and at the source should be restricted to no more than the needs of what can be used in a 72-hr. period. Under no circumstances shall on-site or off-site stored material exceed 500 cubic yards. Stockpiles should be no more than 6 feet in height to prevent anaerobic conditions within the pile. Stockpiled composts should be turned every other week (unless otherwise instructed by the Landscape Architect) to prevent excessive water absorption and anaerobic conditions.

2.4 SOIL STABILIZATION MATERIALS

A. Soil Stabilization Blankets for slopes from 3:1 to 2:1: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples. Staples should be a minimum of 11 gauge steel wire and U-shaped with 8” legs and 2” crown. Blankets must support a 3:1 to 2:1 slope and biodegrade or photo-degrade within 24 months, but without substantial degradation for five months.
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. North American Green, Poseyville, IN; BioNet S150BN Double Net Straw Blankets.
b. American Excelsior Company, Arlington TX; Curlex CL Blankets.
c. Western Excelsior Products, Manco, CO; R-1.
d. Approved Equal.

PART 3 - EXECUTION

3.1 VERIFICATION

A. Prior to construction and soil placement operations at planting areas ascertain the location of all electric cables conduits under drainage systems and utility lines. Take proper precaution so as not to disturb or damage sub-surface elements. Contractor failing to take these precautions shall be responsible for making requisite repairs to damaged utilities at Contractor’s own expense.

B. Verify that required underground utilities are available, located, and ready for use. Coordinate with other trades.

C. Verify that all work requiring access through or adjacent to areas where plant mixes are to be placed has been completed and no further access will be required. In the event that access will be required, this must be coordinated with the Contractor.

3.2 SITE PREPARATION FOR PLANTING SOIL MIXES

A. Do not proceed with the installation of the Soil material until all walls, curb footings and utility work in the area have been installed. For site elements dependent on Soil for foundation support, postpone installation until immediately after the installation of Soil.

B. Install subsurface drain lines as shown on the Drawings prior to installation of Soil material.

C. Excavate and compact the proposed subgrade to depths, slopes and widths as shown on the Drawings. Maintain all required angles of repose of the adjacent materials as shown on the drawings. Do not over excavate compacted subgrades of adjacent pavement or structures.

D. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finished grade and or toward the subsurface drain lines as shown on the drawings.

E. Clear the excavation of all construction debris, trash, rubble and any foreign material. In the event that fuels, oils, concrete washout silts or other material harmful to plants have been spilled into the subgrade material, excavate the soil sufficiently to remove the harmful material. Fill any over excavation with approved fill and compact to the required subgrade compaction.

F. All subsurface drainage systems shall be operational prior to installation of Soils.

G. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use ½" plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
   1. Clean up all trash and any soil or dirt spilled on any paved surface at the end of each working day.
   2. Any damage to the paving or architectural work caused by the soils installation Contractor shall be repaired by the general contractor at the soils installation contractor's expense.

H. Maintain all silt and sediment control devices required by applicable regulations. Provide adequate methods to assure that trucks and other equipment do not track soil from the site onto adjacent property and the public right of way.

3.3 PREPARATION & PLACEMENT OF TRANSITION LAYER

A. Prior to preparation and placement of Transition Layer the Contractor shall verify as-constructed or existing elevations and do whatever additional grading is necessary to bring the subgrade to a true, smooth slope as indicated on Drawings.
   1. Clean up subgrade and dispose of all debris and garbage prior to inspection.
   2. Any soils polluted by gasoline, oil, mortar and grout debris, construction debris, unacceptable soils, or other substances which would render the soils unsuitable for a proper plant growth shall be removed from the premises whether or not such pollution occurs or exists prior to or during the Contract period. In the event that such material is placed, this material shall be removed and replaced with approved material. All remedial operations associated with soil mixes shall be reviewed and approved by the Landscape Architect.

B. Transition layer can be formed by blending the specified Planting Soil Mix with the in situ rough graded sub-soils (Existing Subgrade) to a depth per the drawings in plant beds to permit soil mixing and bonding of the native soil to the Planting Soil Mix.

1. Blend specified Planting Soil Mix with existing subsoil to the depths indicated and at the approximate rate of 50% existing subsoil to 50% Planting Soil Mix.
2. Transition Layer shall be blended in situ and shall be thoroughly mixed such that the components of the Transition Layer are not individually discernible.

3.4 PLANTING MIXTURES

A. Planting mixture for planters and plant backfill shall be of the type(s) indicated in accordance with the planting details and shall be pre-mixed and placed as specified.
   1. For ericaceous plants lower the pH by using elemental sulfur product. Peat moss or copper sulfate may not be used to lower pH.
   2. All amendments shall be thoroughly incorporated into the mixture to assure uniform distribution. Delay mixing of fertilizers if planting will not follow within a few days.

3.5 Additional amendments shall be mixed into the soil as recommended by the testing laboratory and as approved by the Landscape Architect for each plant type and condition of installation.

3.6 PLACING PLANTING SOIL MIXES

A. Remove all large clods, lumps, brush, roots, stumps, litter, and other foreign material and stones one-half inch (1/2”) in diameter or larger. Dispose of removed material legally off-site.

B. Do not place a muddy or wet soil mix (as defined by the Landscape Architect).

C. Transition Layer Conditions
   1. Refer to Article 3.3 herein.

D. Place and spread planting soil mix of the type specified over approved subgrade or transition zone areas to a depth sufficiently greater than the depth required for planting areas so that after settlement as previously approved by Landscape Architect, the completed work will conform to the lines, grades, and elevations shown or otherwise indicated.

E. For Plant Bed Areas:
   1. Required Transition Layer depth per drawings.
   2. Required Planting Soil depths shall be as indicated on drawings with a total of Planting Soil Mix(es) to be a minimum per the drawings as measured in place in a settled position.
   3. Place fills lightly in layers of a maximum of six-inch (6”) lifts and very carefully settle soils to eliminate air pockets and to minimize future settling. Lightly scarify previously placed surfaces prior to placing subsequent lifts. Proposed method of settlement shall be as previously approved by the Landscape Architect. Method may include, but is not limited to, natural settlement over an approved period of time or light hand-tamp, light water misting of each layer and/or light rolling. Do not over compact Planting Soil Mixes.
   4. After settlement has occurred, add soil to maintain finished grades. If for any reason soil is left exposed for a long duration prior to planting, add soil and re-grade as required if erosion occurs. Fills shall not be so compacted as to in any way restrict the flow of water or air through the soil.

3.7 For Lawn Areas:
   1. Required Transition Layer depth shall be per drawings.

2. Required Planting Soil depth shall be as indicated on drawings with a total of Planting Soil Mix(es) to be a minimum per the drawings as measured in place in a settled position.
3. Place fills lightly in layers of a maximum of six inch (6") lifts and very carefully settle soils to eliminate air pockets and to minimize future settling. Lightly scarify previously placed surfaces prior to placing subsequent lifts. Proposed method of settlement shall be as previously approved by the Landscape Architect. Method may include, but is not limited to, natural settlement over an approved period of time or light hand-tamp, light water misting of each layer and/or light rolling. Do not over compact Planting Soil Mixes.
4. Roll the whole surface of lawn bed with a hand roller weighing approximately one hundred pounds (100 lb.) per foot (12") of roller width. During the rolling, fill all depressions caused by settlement with additional planting soil and then re-grade. Lightly roll and rake until the surface presents a smooth, even, and uniform finish that is at required grade.
5. Allow plant mix in lawn areas to remain undisturbed until fully settled in accordance with settlement methodology submitted as approved by the Landscape Architect. After any additional settlement has occurred, restore areas to finished grade prior to sodding.
6. Protect plant mix against construction activity with site protection fence as specified and the eroding effects of wind and rain with filter fabric as approved for the protection plan.
7. If soils are placed in the fall, the use of winter rye will be permitted. Where winter rye is used, the rye grass shall be roto-tilled into the soil in the spring and soil preparation and rolling shall be repeated as specified.

B. Backfilling for trees in this area shall use material specified in this section but be installed as specified in Section 329310 "Exterior Planting." Removal or shoring is the responsibility of the Contractor for Soil Preparation and Mixes.

C. Protect the soil from compaction after placement. Any area which becomes compacted shall be tilled to a depth of six (6") inches. Any uneven or settled areas shall be filled and re-graded to the plan.

D. Grading Tolerances: Planting areas shall be fine graded within ±1/10 (0.10) feet of grades indicated on drawings. Maintain all flat areas and slopes to allow free flow of surface drainage without ponding.

3.8 PREPARATION FOR SOIL STABILIZATION MATERIALS

A. Prepare area as specified in Articles 3.2 through 3.5 herein.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.9 CLEANUP

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day's work. Burning of material or dumping on the site is prohibited.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store

materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 329115

SECTION 329210 – TURF AND GRASSES

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. Work included: provide labor, materials and equipment necessary to complete the work of this section, including but not limited to the following:
   1. Seeding.
   2. Sodding.
   3. Preparing subgrade.
   4. Soil amendments.
   5. Protecting and maintaining all sodded areas until Substantial Completion.
   6. Turf renovation.
   7. Final clean-up.

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 04 Section ‘Site Stone Masonry’
   3. Division 32 Section ‘Crushed Stone Paving’
   4. Division 32 Section ‘Concrete Paving’
   5. Division 32 Section 'Unit Paving’
   6. Division 32 Section 'Soil Preparation and Mixes’
   7. Division 32 Section 'Metal Edging’

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. 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.

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 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 ACTION SUBMITTALS

A. Product Data: Submit product literature or tear sheets giving name of product indicated, manufacturer's name and compliance with Specifications for each type of product indicated.
   1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project and safety information.
   2. Mulch.
   3. Commercial fertilizer: Include guarantee analysis, and weight for packaged materials.

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. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.
   1. Commercial Fertilizers: Include guaranteed analyses.
   2. Ground Limestone: Include guaranteed analysis, and weight for packaged material.

E. Schedule and Work Plan: Submit detailed schedule and Work plan, indicating location and installation dates for each area of lawn.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified landscape installer.

1.6 QUALITY ASSURANCE

A. Lawn work shall be performed by a single firm specializing in lawn construction, which has been previously engaged for a period of at least five (5) years in the installation of lawn construction.

B. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf 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. Experience: Five (5) years experience in turf installation.
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
      a. Certified Landscape Technician - Exterior, with installation, maintenance and irrigation specialty areas, designated CLT-Exterior.
      b. Certified Turfgrass Professional, designated CTP.
      c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
   5. Maintenance Proximity: Not more than two (2) hours normal travel time from Installer's place of business to Project site.
   6. Pesticide Applicator: State licensed, commercial.

C. Pre-installation Conference: Conduct conference at Project site.

D. Installer: Perform work with personnel totally familiar with lawn construction under the supervision of an experienced landscape foreman at all times during the construction. Notify the Landscape Architect of the name and phone number of the foreman five (5) business days in advance of the first day of lawn construction.

E. Arrange a preconstruction meeting between the Landscape Architect, General Contractor and Lawn Subcontractor. Such meeting shall seek to review the lawn construction schedule, phasing, review of specifications and construction procedures.

1.7 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of local, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials.

C. Procure and pay for permits and licenses required for Work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, clearly marked, unopened containers showing net weight, certified analysis, name and address of manufacturer and indication of conformance with state and federal laws, as applicable. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration during delivery and during storage at site.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in “Specifications for Turfgrass Sod Materials” and “Specifications for Turfgrass Sod Transplanting and Installation” in TPI’s “Guideline Specifications to Turfgrass Sodding.” Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. 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.

1.9 PROJECT CONDITIONS

A. Existing Conditions
1. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.
a. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.
2. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

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. Do not place sod when the ground is frozen, or the soil is otherwise in an unsatisfactory condition for lawn construction.

C. Planting Restrictions: Plant during one of the following periods:
1. Spring: March 15 to May 31.
2. Fall: September 1 to October 15.
3. Seeding or sodding at any time other than within the above seasons shall be allowed only when the Contractor submits a written request for permission to do so and permission is granted in writing by the Owner. Newly seeded or sodded areas, if sown or sodded out of season, must be continuously watered according to good practice. Contractor shall be responsible for providing an acceptable stand of grass as specified.

D. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate Work of this Section with Work of all other Sections of Specification.

1.11 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3 herein. Begin maintenance immediately after each area

is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from the date of planting completion.
2. Sodded Turf: 30 days from date of planting completion.
3. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Continuing Maintenance Proposal: From Installer 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.

1.12 INSPECTION FOR SUBSTANTIAL COMPLETION

A. Refer to Division 01 Specification Sections for provisions regarding guarantees for the Work.

B. Maintain all lawn areas until Substantial Completion. Maintenance will be in accordance with requirements specified in Part 3 of this Section.

C. The Landscape Architect will make an inspection for Substantial Completion of the Work of this Section at the time of Substantial Completion of the entire Contract. The Contractor shall furnish a full and complete written program for maintenance of the turf for review by the Landscape Architect at the time of the request for Substantial Completion.

1. Submit a written request for inspection at least two (2) weeks prior to the day on which the inspection is requested.
2. The Contractor shall prepare a list of items to be completed or corrected for review by the Landscape Architect, prior to inspection.
3. All seeded areas shall show a uniform, thick, well developed stand of grass. If the grass stand is unsatisfactory, as determined by the Landscape Architect, the Contractor's maintenance responsibility shall continue until an acceptable stand of grass is achieved.

D. Upon completion of the inspection, the Landscape Architect shall amend the list of items to be completed or corrected and indicate the time period for their completion or correction.

E. Lawns areas will not be accepted until all items have been completed or corrected. The Landscape Architect, after an additional inspection, shall recommend in writing the Substantial Completion of the Work of this Section. The Contractor's responsibility for maintenance shall terminate, under issuance of a certificate of Substantial Completion for the entire Contract.

1.13 GUARANTEE

A. In addition to the specific guarantee requirements of the General Conditions and Supplementary General conditions, the Contractor shall obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

PART 2 - PRODUCTS

2.1 WATER

A. Potable, clean, fresh and free from harmful materials. Water shall be furnished by the Owner. All hoses and other irrigation equipment required for the Work shall be furnished by the Contractor.

2.2 LOW-GROW SEED

A. Low-Grow Seed: Mix 1 – Low-Grow Full Sun. This seed mix will consist of the following by weight:
   1. 33% Buffalo Grass
   2. 33% Blue Grama Grass
   3. 33% Poverty Oatgrass

2.3 TURFGRASS SOD

A. Turfgrass Sod: Certified complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Tall Turf Type Fescue (Schedonorus arundinaceus) / Kentucky Bluegrass (Poa pratensis) Mix

C. All sod shall be vigorously growing, thick, uniform, fully established turf grasses freshly harvested in forty-eight (48) inch widths.

D. Sod shall be thick, well developed, machine cut strips 3/4-inch thick, from an approved sod farm. Individual sod pieces shall be cut to a uniform size with square corners. Standard sections shall be strong enough to support their own weight when held vertically. Each piece shall be uniformly moist, and not excessively dry or wet.

E. Sod shall be free from noxious weeds, annual grasses, moss, large stones, tree roots, or other materials harmful to growth, or that will interfere with future mowing or other maintenance of the sodded areas.

F. Pegs where required for holding sod shall be of approved sound soft wood and be at least 3/4 inch in thickness, square or round, and at least 8 inches long.

G. Sod shall be harvested, delivered and installed within a period of 24 hours. Sod not installed within this period must be approved by the Landscape Architect prior to installation.

2.4 SOIL AMENDMENTS

A. Soil Amendments: See Division 32 Section “Soil Preparation and Mixes.”

2.5 FERTILIZERS

A. Fertilizers: Fertilizer recommendation will be made by the testing agent after soil testing. Fertilizer additions may include micronutrients, lime, gypsum, sulfur, nitrogen, phosphorus, and potassium. Commercial fertilizer shall be a product complying with the State and Federal fertilizer laws. Deliver to the site in the original unopened containers that shall bear the manufacturer's certificate of compliance covering analysis, which shall be furnished to the Landscape Architect. At least 33% of the nitrogen content by weight shall be cold water insoluble nitrogen.

B. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 to 4 percent nitrogen and 10 to 20 percent phosphoric acid.

C. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

D. Humic Extract: Provide “Feedback” as supplied by the Troubled Soils Company, New Haven, CT 06519 (1-800/326-3361), or approved equal.

E. Ground Limestone: Provide a ground limestone with a minimum of 88% of calcium and magnesium carbonates. Material shall have a total 100% passing the 10-mesh sieve, minimum of 90% passing the 20-mesh sieve, and a minimum of 60% passing the 100-mesh sieve.

F. Fertilizer: Use of fertilizer as amendment or for maintenance condition shall be subject to soil test results:
   1. Fertilizer for lawns shall be twenty percent (20%) super phosphate and 19-26-5-organic fertilizer, the elements of which are derived from organic sources and shall contain the following percentages by weight:
      a. Water Insoluble Nitrogen: 10%. One-quarter (1/4) of the nitrogen shall be in the form of nitrates, one-quarter (1/4) in the form of ammonia salts, and one half (1/2) in the form of natural organic nitrogen.
      b. Phosphoric Acid: 6%. Available phosphoric acid to be from super phosphate, bone or tankage.
      c. Potash: 4%. The potash to be in the form of Sulphate of Potash.
   2. Fertilizer shall be delivered mixed as specified in standard size bags, showing weight, analysis and name of manufacturer, and shall be stored in a weatherproof storage place and in such manner that its effectiveness will not be impaired.

2.6 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.7 PESTICIDES AND 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 Landscape Architect and local, state and/or federal agencies with jurisdiction for type and rate of application.
   1. Pesticides containing petrochemicals will not be accepted.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer. Do not use restricted pesticides unless authorized in writing by Landscape Architect and local, state and/or federal agencies with jurisdiction for type and rate of application.
   1. Pesticides containing petrochemicals will not be accepted.
   2. Preen or other form of gluten-based products.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated. Do not use restricted pesticides unless authorized in writing by Landscape Architect and local, state and/or federal agencies with jurisdiction for type and rate of application.
   1. Pesticides containing petrochemicals will not be accepted.
   2. Roundup, as manufactured by Monsanto Agricultural Products Company, C3NJ, St. Louis, MO 63166, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting 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 Landscape Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and 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 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1-1/2 inches any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply superphosphate fertilizer directly to subgrade before loosening.
   2. Thoroughly blend planting soil off-site before spreading.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      b. Mix lime with dry soil before mixing fertilizer. Weight of lime per 1000 sq. ft: 40 lb. Weight of commercial fertilizer per 1000 sq. ft: 40 lb.
   3. Spread planting soil to a depth as indicated on Drawings 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. 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.
      b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted 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 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top six (6) inches of soil. Till soil to a homogeneous mixture of fine texture.
      a. Apply superphosphate fertilizer directly to surface soil before loosening.
   3. Remove stones larger than 1-1/2 inches 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. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate of 5 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.5 SODDING

A. Sodding shall consist of soil preparation, sodding, weeding, watering and otherwise all labor and materials necessary to secure the establishment of acceptable turf.

B. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

C. After soil mix has been placed and grading is complete, irrigate the soil mix bed twelve to twenty-four (12-24) hours prior to sodding to a depth making the lawn mix evenly moist. Sod shall not be laid on soil that is powdery dry or excessively moist or slippery.

D. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

E. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Do Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Lay sod strips perpendicular to slope.

F. Tamp the sod lightly to ensure good contact with the soil surface. When laying is completed, dress top surface lightly with screened soil mix free of any material larger than one-half inch, which shall be worked into the seams between the pieces with a brush. When finished, the sod should present a smooth and uniform surface parallel to the finish grade.

G. Water all sod areas immediately following its installation so that the sod surface and lawn mix surface are thoroughly soaked. Cut and maintain established sod in accordance with the requirements contained herein.

3.6 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply sod as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.7 TURF MAINTENANCE

A. Maintenance shall begin immediately after each portion of lawn is installed. Maintenance is hereby defined as: re-seeding, re-sodding, repair of ruts and erosion, regarding, repair of protective devices, watering, weeding, fertilizing, cutting and the repeating of any or all phases of lawn work construction as required to establish healthy, viable turf. 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 turf 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 turf 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.

B. Watering: Install and maintain temporary hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Lawn work shall be maintained on daily basis, weekends and holidays excluded, except as otherwise required herein, until Substantial Completion.

D. Mow turfgrass sod as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   1. Mow grass to a height of 2 inches.

E. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Scattered bare or dead spots, none of which are larger than 36 square inches, will be allowed up to a maximum of two percent (2%) of any lawn area after initial installation. After the grass has been established, all areas which fail to show a uniformly thick and well developed stand of grass and all scattered base or dead spots, for any reason whatsoever, shall be reseeded repeatedly until all areas are covered with a satisfactory growth of grass. Lawn areas shall show no joints or dead spots at Substantial Completion and shall be anchored to lawn mix bed with vigorous, healthy root growth. Prior to Substantial Completion, damage resulting from erosion, gulleys, washouts or other causes shall be repaired by filling with lawn mix, tamping, re-fertilizing, re-seeding, and re-sodding.

C. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.9 PROTECTION OF LAWN AREAS

A. Protect all lawn areas continuously against damage with a fence as specified. Maintain continuously in a condition acceptable to the Landscape Architect. Remove fence and any protective devices remaining on site after Substantial Completion unless directed otherwise by the Landscape Architect.

B. Contractor shall pay cost of replacement of lawn areas except where it can be definitely shown that the loss resulted from vandalism or deleterious effects caused by maintenance procedures performed by the Owner without the concurrence of the Contractor. Fully restore all lawn areas, damaged or disturbed by replacement or repair operations to their original condition.

3.10 PESTICIDE APPLICATION

A. Apply pesticides 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. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 WATERING

A. A. The Contractor shall provide all labor and arrange for all watering necessary for establishment of lawn areas. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary and in sufficient quantities to maintain moist soil to a depth of at least four (4) inches.

3.12 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

D. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to inspection of Work. Leave the site in a neat, orderly condition, "broom clean".

END OF SECTION 329210

SECTION 329310 – EXTERIOR 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. Work included: provide labor, materials and equipment necessary to complete the work of this section, including but not limited to the following:
   1. Furnishing and installing trees, shrubs, groundcovers and bulbs.
   2. Mulching
   3. Fertilizing
   4. Guarantee
   5. Maintenance prior to substantial completion
   6. Clean-up

B. Related Sections:
   1. Division 03 Section ‘Cast-in-Place Concrete’
   2. Division 04 Section ‘Site Stone Masonry’
   3. Division 32 Section ‘Crushed Stone Paving’
   4. Division 32 Section ‘Salvaged Boulders’
   5. Division 32 Section ‘Concrete Paving’
   6. Division 32 Section 'Unit Paving’
   7. Division 32 Section 'Soil Preparation and Mixes’
   8. Division 32 Section 'Turf and Grasses’
   9. Division 32 Section 'Metal Edging’

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. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by 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. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. 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.

I. 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.

J. Planting Area: Areas to be planted.

K. 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.

L. 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.

M. 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.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) or root balls of trees below the soil surface.

O. 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.

P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

Q. 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.

R. Agricultural chemist: Qualified, experienced public or private soils testing laboratory, capable of providing test results as specified, and approved by the Landscape Architect.

1.4 REFERENCES

A. ASNS: "American Standard for Nursery Stock," ANSI Z60.1 latest edition, published by the American Association of Nurserymen, (AAN).

B. SPN: "Standardized Plant Names," latest edition, by the American Joint Committee on Horticultural Nomenclature.

1.5 ACTION SUBMITTALS

A. General: Make submittals in accordance with the provisions and procedures of Division 01 Section – “Submittals”. Render submittals and receive approval prior to delivery or installation.
   1. Approval by the Landscape Architect of submitted product data, samples, test reports, and certificates, or material inspected at source of supply, does not constitute final acceptance.

B. Plant material sources: Submit proposed sources for deciduous trees over four inches (4”) in caliper and multi-stem deciduous trees and evergreen trees over seventeen feet (17’) in height within forty-five (45) days of award of contract.
   1. Submit proposed sources for all other plants within ninety (90) days of award of contract. Provide names and locations of nurseries, contact persons, and telephone numbers.

C. Testing: Submit written statement from proposed agricultural chemist that required test can be performed in accordance with the specifications.

D. Product Data: Submit product literature or tear sheets giving name of product indicated, manufacturer's name and compliance with Specifications for each type of product indicated.
   1. Commercial fertilizer: Include guarantee analysis, and weight for packaged materials.
   2. Herbicides, pesticides and fungicides: Include product label and manufacturer's application instructions specific to this Project and safety information.
   3. Anti-desiccant.
   4. Weed control barrier.

E. Samples for Verification: For each of the following:
   1. Mulch: 1-quart volume of each 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.
   2. Sand: Two (2) pound bag.

F. Test Reports: Submit certified reports by an agricultural chemist. Make submittals at least three (3) weeks prior to delivery of materials to site.
   1. Sand: Provide sieve analysis report for physical characteristics.

G. 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.
   3. Plants: Furnish certificates of inspection as may be required by Federal, State or other authorities that plants are free of disease or hazardous insects.

H. Schedule and Work Plan: Submit detailed schedule and Work plan, indicating start and finish dates of planting activities, including layout, soil preparation, and delivery of plants from nursery sources, excavation, and installation. If planting work is being installed in phases, submit plan with definable areas outlined and keyed, and provide schedule for planting work within each area.

I. Maintenance Program: Submit full and complete written program for maintenance of the planting up to substantial completion. Submit prior to installation of plantings.

1.6 INFORMATIONAL SUBMITTALS

A. 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.

1.7 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. Experience: Five (5) years experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
   3. Notify the Landscape Architect of the name and phone number of the foreman five (5) business days in advance of the first day of planting operations.
   4. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   5. Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
      a. Certified Landscape Technician - Exterior, with installation, maintenance, and irrigation specialty area(s), designated CLT-Exterior.
      b. Certified Ornamental Landscape Professional, designated COLP.
   6. Pesticide Applicator: State licensed, commercial.

B. Plant Material: Meet or exceed applicable American Standard for Nursery Stock (ANSI Z60.1) standards.
   1. Plant List: Investigate sources of supply prior to submitting bid. Confirm that size, variety and quantity of plants specified on Plant List can be supplied. Failure to take this precaution will not relieve the successful bidder from his responsibility for furnishing and installing all plants in strict accordance with the Contract requirements and without additional expense to the Owner.
      a. Substitutions will not be permitted unless substantiated written proof is supplied that a specified plant is not obtainable. In this situation a proposal to use the nearest equivalent size or variety with an equitable adjustment of Contract Price will be considered.
   2. Trees: Measure according to ANSI Z60.1. Do not prune to obtain required sizes. 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 six (6) inches above the root flare for trees up to 4-inch caliper size, and twelve (12) inches above the root flare for larger sizes.
   3. Plant Material: Meet or exceed applicable American Standard for Nursery Stock (ANSI Z60.1) standards.

C. Plants will be inspected, and approval given by the Landscape Architect at the source for conformity to Specification requirements. Such approval shall not affect the right of inspection and rejection during delivery and installation.

D. All material specified as ball and burlap (B&B) must be in the ground at the growing source at the time of inspection. Pre-dug plant material, and pre-dug healed in plant material, at the growing source will not be reviewed or accepted.

E. Arrange for adequate manpower and equipment on site at the time of plant material inspection and installation to provide a complete staked layout and to unload, open and handle plant material during inspection.

F. Arrange a preconstruction meeting between the Landscape Architect, General Contractor and Planting Subcontractor. Such meeting shall seek to review the proposed plant schedule, source of plants, consideration of substitutions, general review of specifications and planting procedures. Inform the Landscape Architect at least ten (10) business days in advance of the scheduled meeting time.

1.8 PLANT SELECTION AND INSPECTION

A. Landscape Architect will inspect and select all plants except bulbs and ground covers at the source of supply for compliance with requirements for genus, species, variety, cultivar, size, and quality. Locate all plants and be present for inspection of plants at the source. Make all pre-selection arrangements at the source of supply to ensure a ready supply of materials, equipment and man power required for an efficient selection procedure. Request the visit at least fourteen (14) days in advance of the desired inspection date.

B. Plants will be inspected, and approval given by the Landscape Architect at the source for conformity to Specification requirements. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during delivery and installation. Remove rejected trees or shrubs immediately from Project site.

C. All plants specified as balled and burlap (B&B) must be in the ground at the growing source at the time of inspection and selection. Pre-dug material will not be accepted.

D. All specified deciduous trees over four inches (4”) in caliper, multi-stem deciduous trees over seventeen feet (17’) in height and evergreen trees over seventeen feet (17’) in height are to be selected twelve (12) weeks prior to installation.

E. Arrange for adequate manpower and equipment on site at the time of plant inspection and installation to provide a complete staked layout and to unload, open and handle plants during inspection.

1.9 REGULATORY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of local, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make Work comply with such requirements without additional cost to Owner.

B. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to and ingress and egress at the site. Conform to all governmental regulations regarding the transportation of materials.

C. Procure and pay for permits and licenses required for Work.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate Work of this Section with Work of all other Sections of Specification.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. All plant labels to remain on plants until Landscape Architect removes them. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration during delivery and during storage at site. Upon delivery to the site, request, in writing, inspection of materials by Owner's representative and by Landscape Architect.

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.

C. Plant Material:
   1. Notify the Landscape Architect seven (7) days in advance of any delivery of plants to the site.
   2. Immediately before moving plant material from its source, spray all deciduous woody plants with an anti-dessicant, applying an adequate film over trunks, branches, twigs and foliage. Plants may be re-sprayed after planting.
   3. Dig and handle plants with care to prevent injury to trunks, branches and roots. Handle planting stock by root ball.
   4. Do not prune prior to 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 manner as to damage bark, break branches or destroy natural shape. Pack and ship to ensure arrival at site in good condition. Provide protective covering during delivery. No plants will be accepted if ball is cracked or broken.
   5. Deliver trees after preparations of planting areas have been completed and approved and plant immediately.
      a. If planting is delayed more than twenty-four (24) hours after delivery, set balled and burlapped plants in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage and keep roots moist, on the ground well protected with soil, straw, hay or other acceptable material. Protect balls and roots and container grown material from freezing, sun, drying winds, and/or mechanical damage. Water as necessary until planted.
      b. Heeling in plants shall not be allowed for more than three (3) days without approval of the Landscape Architect.
   6. Immediately remove rejected plants from the site.
   7. Set balled stock on ground and cover ball with soil, expanded shale mulch, sawdust, or other acceptable material.
   8. 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.

1.12 PROJECT CONDITIONS

A. Existing Conditions
   1. Carefully examine the site before submitting a bid. Be informed as to the nature and location of the Work, general and local conditions including climate, adjacent properties and utilities, conformation of the ground, the nature of subsurface conditions, the character of equipment and facilities needed prior to and during execution of the Work.
      a. Be aware of and comply with restrictions regarding subsurface utilities and subterranean structures, including excavation and loading parameters.
   2. Should the Contractor, in the course of Work, find any discrepancies between Drawings and physical conditions or in layout as furnished by the Landscape Architect, it will be his duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.

B. 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.

C. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of each service or utility.
   2. Do not proceed with interruption of services or utilities without Construction Manager's written permission.

D. Planting Restrictions: Plant only within the following dates, weather permitting. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion. Do not plant when the ground is frozen, or the soil is otherwise in an unsatisfactory condition for planting.
   1. Plant balled and burlapped deciduous trees and needled evergreen trees and shrubs and container grown trees and shrubs between March 1 and June 15 and September 1 and November 15.
   2. The following plants are listed in three groups according to lessening degrees of risk for fall planting. The list is not based on controlled experiments, but on years of observation by nursery men. Planting at times other than spring shall be done at Contractor's risk and shall not relieve him of the obligation of Guarantee.
      a. Plants with significant risk of loss. Best to postpone planting these until spring.
         1) Cercis Canadensis, Eastern Redbud
         2) Magnolia spp., Magnolias
         3) Nyssa sylvatica, Black Gum
         4) Quercus alba, White Oak
         5) Quercus coccinea, Scarlet Oak
         6) Quercus macrocarpa, Bur Oak
         7) Quercus rubra, Red Oak
      b. Plants with some degree of risk. But these can be transplanted if stock is freshly dug and moved quickly and carefully. Stake, wrap, and provide extra care.
         1) Acer rubrum, Red Maple
         2) Betula spp., Birches
         3) Cornus florida, Flowering Dogwood
         4) Crataegus spp., Hawthorns
      c. Plants not at great risk but avoid late planting. These are best planted in late August or September: they may have trouble if planted later.
         1) Ilex crenata, Japanese Holly

2) Rhododendron spp., Rhododendrons and Azaleas, evergreen types

3. Plant shrubs in the spring only, when dormant, as close to April 1 as possible.
4. Plant perennials and groundcovers as soon as the ground is workable in spring until November 15, weather and soil conditions permitting.
5. Plant bulbs between September 1 and November 15, as soon as they become available from suppliers.

E. 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.

1.13 INSPECTION FOR SUBSTANTIAL COMPLETION

A. Maintain all plants until Substantial Completion.

B. The Landscape Architect, with the Contractor and the Owner’s Representative, will make an inspection for Substantial Completion of the Work of this Section. Furnish full and complete written program for maintenance of the planting for review by the Landscape Architect at the time of the request for Substantial Completion.
1. Submit a written request for inspection at least two (2) weeks prior to the day on which the inspection is requested.
2. All planting shall be alive, healthy and installed as specified to be accepted.
3. Prepare a list of items to be completed or corrected for review by the Landscape Architect.

C. Upon completion of the inspection, the Landscape Architect shall amend the list of items to be completed or corrected, and indicate the time period for their completion or correction.

D. The Landscape Architect will make another inspection after notification from the Contractor that all items have been completed and corrected. If the work is complete and acceptable, the Landscape Architect will certify in writing to the Owner the Substantial Completion of the Work. The guarantee period will not begin until certification is received from the Owner.

1.14 WARRANTY/GUARANTEE

A. Contractor is not responsible for acts of vandalism occurring after the beginning of Guarantee Period, nor shall Contractor be held responsible for deleterious effects caused by maintenance procedures performed by the Owner without the concurrence of the Contractor or caused by Owner's failure to follow maintenance program.

B. During this time the Owner shall maintain all plants; however, during the Guarantee Period it shall be the Contractor's responsibility to inspect the plants to satisfy himself that the areas are receiving proper care.
1. If the Contractor is of the opinion that the care being given the plants by the Owner is insufficient or may cause them to die prematurely, he shall immediately, and in sufficient time to permit the condition to be satisfactorily rectified, notify the Landscape Architect in writing; otherwise no consideration will be given to his claim at a later date.

C. Guarantee for plants other than herbaceous material:
1. Replace at no additional cost for a period of eighteen (18) months after the establishment of the beginning date of Guarantee Period, any trees except as listed below, shrubs, or

ground covers that have died or that are, in the opinion of the Landscape Architect, in unhealthy or unsightly condition, or that have lost their natural shape due to dead branches, excessive pruning, excessive defoliation, or inadequate or improper maintenance.

a. Replace unacceptable plants no later than two (2) weeks after the determination is made by the Landscape Architect, unless planting is restricted due to season and weather as noted within this specification.
b. Replace unacceptable plants in accordance with original Specification. Cost is considered to be included in the Bid and Contract price. Guarantee all replaced material for a period of eighteen (18) months from date of replacement.
c. Deciduous trees larger than four inches (4") in caliper shall be guaranteed for a period of two (2) years.
d. Multi-stem deciduous trees and evergreen trees taller than seventeen feet (17') in height shall be guaranteed for a period of two (2) years.

1.15 FINAL ACCEPTANCE

A. The Landscape Architect will make an inspection for Final Acceptance of the Work of this Section at the end of the Guarantee Period.
   1. Submit a written request for inspection at least two (2) weeks prior to the day on which the inspection is requested.
   2. All planting shall be alive, healthy and maintained as specified to be accepted.

B. Upon completion of the inspection, the Landscape Architect will submit to the Owner a list of items to be completed or corrected and indicate the time period for their completion or correction.

C. The Final Acceptance will not occur until all items have been completed or corrected. The Landscape Architect, after additional inspection, will recommend in writing to the Owner Final Acceptance of the Work. Final Acceptance will be certified in writing by the Owner.

1.16 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees, Shrubs, Ground Cover and Other Plants, Shrubs, Ground Covers and Other Plants: Provide maintenance by skilled employees of Landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until Substantial Completion.

B. Continuing Maintenance Proposal: From Installer 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 PLANTING PIT MATERIALS

A. Soil and Soil Mixes: See Division 32 Section "Soil Preparation and Mixes."

B. Sand: Natural, medium to coarse grained in texture, free from decomposed organic matter like roots, sticks, leaves, paper and of any other undesirable trash-like glass, plastic or metal fragments that could interfere with soil drainage and planting operations. Sand shall be salt-free.

2.2 COMMERCIAL FERTILIZER FOR MAINTENANCE PERIOD

A. Soluble fertilizer, with analysis of 20-20-20 or 23-29-27, such as Ra-Pid-Gro or an approved equal for non-ericaceous plants, unless otherwise recommended by soil test results.

B. Miracid, Holly-tone, or an approved equal, for ericaceous and other evergreen plants, unless otherwise recommended by soil test results.

2.3 WATER

A. Potable, clean, fresh and free from harmful materials. Water shall be furnished by the Contractor. All hoses and other irrigation equipment required for the Work shall be furnished by the Contractor.

2.4 PLANT MATERIAL

A. 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. Contractor to conduct a meeting with Landscape Architect at beginning of project as Tree Propagation may be desired as a means for contract growing and selecting plant materials.
   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. Trees shall be dug so that the root flare is located at the top of the rootball. Care shall be taken to remove any soil that has accumulated on top of the root flare during digging prior to wrapping and tying root ball.
   3. 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.
   4. Nomenclature: Agree with SPN or as accepted in the nursery trade for varieties not listed therein.
      a. Clonal types shall be true.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls. Large plants cut back to sizes specified will not be accepted.
   1. Measure height or spread and quality in accordance with standards specified in ASNS (unless otherwise specified).

C. Provide balled and burlapped stock (B&B) with a compact natural ball of earth, firmly wrapped and tied in burlap so that upon delivery the soil in the ball is still firm and compact about the small feeding roots. Root ball sizes shall be in accordance with standards specified in ASNS.

D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

E. Labeling: Label at least one 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. Do not remove label until Landscape Architect has inspected the plants.

F. If formal arrangements or consecutive order of plants are shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.5 MULCH MATERIALS

A. Expanded Shale Mulch: Free from deleterious materials and suitable as a top dressing of trees, shrubs, and perennials, consisting of the following:

1. Type: KENLITE
2. Size: 1 inch maximum.
3. Color: Gray with tan and oranges.

B. Crushed Stone Aggregate Mulch (Applicable to Trees in Pavement): Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:

1. Type: Crushed Stone, as available from Kafka Granite, 550 East Highway 153, Mosinee, WI 54455; Telephone: 715-256-8153.
2. Size: 3/8 inch x 1/8 inch.
3. Color: To be selected from Supplier’s full range.

2.6 PESTICIDES AND 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 Landscape Architect and local, state and/or federal agencies with jurisdiction for type and rate of application.
1. Pesticides containing petrochemicals will not be accepted.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer. Do not use restricted pesticides unless authorized in writing by Landscape Architect and local, state and/or federal agencies with jurisdiction for type and rate of application.
1. Pesticides containing petrochemicals will not be accepted.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated. Do not use restricted pesticides unless authorized in writing by

Landscape Architect and local, state and/or federal agencies with jurisdiction for type and rate of application.

1. Pesticides containing petrochemicals will not be accepted.

2.7 PLANT TREATMENT MATERIALS

A. Herbicides, Fungicides, Pesticides: Approved before use for type and rate of application by Landscape Architect and local, state and/or federal agencies with jurisdiction.
   1. Pesticides containing petrochemicals will not be accepted.

B. Anti-dessicant: "Wiltproof" as manufactured by Wiltproof Products, Inc., P.O. Box 4280, Greenwich, Ct. 06830, 203-531-4740.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to excavation of planting areas, ascertain the location of all electric cables, conduits, underdrainage systems and utility lines. Take proper precautions so as not to disturb or damage sub-surface elements. If sub-surface elements are uncovered, promptly notify the Landscape Architect, who will relocate the plants. If Contractor fails to follow this procedure he is responsible for making requisite repairs to damaged utilities at his own expense.
   1. Verify that required underground utilities are available, in proper location and ready for use. Coordinate with other trades.
   2. 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.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

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.

C. Coordinate with Division 32 Sections “Concrete Paving”, “Unit Paving”, “Metal Edging”, “Site Stone Masonry”, “Crushed Stone Paving” and “Turf and Grasses.”

3.3 LAYOUT

A. Stake out locations for new plants and outlines of planting areas for approval by the Landscape Architect where shown on Drawings except where obstructions exist below ground, overhead, or where changes have been made during construction. Adjustments shall be approved by the Landscape Architect. Layout planting beds and pits completely before seeking approval by the Landscape Architect.

3.4 INSTALLATION

A. Excavation: All plant pits and trenches shall be excavated in accordance with the Planting Details after approval of staked locations by the Landscape Architect. Excavation of plant pits shall be done after soil testing, and analysis and approval by the Landscape Architect

B. Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Dig to depth of root ball minus 1-2 inches so that tree is firmly supported with root flare above finish grade. 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 as indicated on the Drawings for balled and burlapped and container-grown stock.
   2. Do not excavate deeper than depth of the root ball, measured from where the root flare meets the top of the root ball to the bottom of the root ball.
   3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and fully compact the added soil to prevent settling.
   4. 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.
   5. Maintain supervision of excavations during working hours.
   6. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
   7. If drainage pipe is shown on Drawings or required under planting areas, excavate to top of porous backfill over pipe.
   8. When compacted soil is encountered, sides and bottoms shall be loosened by scarifying.
   9. Exercise extreme caution during excavation to avoid damaging or interrupting existing under-ground utilities. Use appropriate detection equipment to locate utilities during excavation of pits to the required depth.
   10. Erect barricades, warning signs, or other protective devices as is required by local, state or federal laws and regulations to protect open excavation.
   11. Excavated material shall be removed and disposed off-site, unless approval, in writing, has been obtained from the Landscape Architect.
   12. Topsoil removed from excavations may be used as planting soil as long as it meets the necessary specification requirements.

C. Drainage of Pits: Verify by testing that pits are free draining. If pits are not free draining notify Landscape Architect and Owner and submit alternative method of drainage for approval.
   1. Check planting drainage system to insure it is functioning correctly prior to planting. Refer to Drawings for layout and design of planting drainage system.
   2. Do not install plants in pits until the pits have been approved by the Landscape Architect.

D. Obstructions below Ground
   1. In the event that rock, underground construction work, utilities or obstructions are encountered in any plant pit excavation work under this Contract, alternate locations may be selected by the Landscape Architect.
   2. Where locations cannot be changed, the obstruction shall be removed, subject to the Landscape Architect's approval, to a depth of not less than three (3) feet below grade and no less than six (6) inches below bottom of ball or roots when plant is properly set at the required grade. Payment shall be made in accordance with the Contract.

E. Placement of Plants
   1. Plants shall be set in center of pits, plumb and straight, in accordance with the planting details, and faced to give best appearance and relationship to adjacent plants and structures.

2. Do not plant until plants have been approved by the Landscape Architect at site.
3. Plant to such depth that the finished grade level of the plant, after settlement, will be the same as that at which the plant was grown, and so that the root flare is slightly above finish grade.
4. Remove all burlap and ropes from the top third of root balls. Clip and remove top 1/3 of wire baskets.
5. Do not pull burlap out from under balls. Remove platforms, wire and surplus binding from top and sides of ball. Cleanly cut off all broken, encircling, girdling or frayed roots.
6. Remove all non-biodegradable materials from the plant pit.
7. Remove plants from containers by cutting or inverting the container.
8. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

F. Set balled and potted or container-grown stock plumb and in center of planting pit or trench with root flare one to two (1-2) inches above adjacent finish grades.
1. Use planting soil for backfill.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. 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.

H. When planting in paved areas, install trees and backfill with soil prior to installation of adjacent pavers.

I. Backfilling
1. Use Planting Soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and 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.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Spread out the roots of bare root plants properly and work backfill mix among them. Prune off broken roots in a natural position. Water thoroughly while backfilling.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

J. Installation Inspection
1. The Landscape Architect will inspect trees for planting depth, injury to trunks, evidence of insect infestation and improper pruning before wrapping. Treat injuries of infestation by accepted methods. Remove and replace plants determined by the Landscape Architect to have injuries or infestations which cannot be treated or which have caused unacceptable damage to the plant.
2. Trees shall stand plumb at installation.

3.5 TREE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
   1. Remove broken or badly bruised branches with a clean cut. Perform pruning with clean, sharp tools.
   2. Accidental damage to trees occurring during the course of planting operations which is not so great as to require removal of a branch or the replacement of the plant shall be promptly traced and treated in accordance with recognized horticultural practices as directed by the Landscape Architect.

C. Do not apply pruning paint to wounds.

3.6 WATERING

A. Upon completion of planting operation, water plant material thoroughly on the interior of the mulch saucer until it is filled or over the entire planting bed.

B. Apply water slowly so as to penetrate the entire root system and at a rate which will prevent relocation/displacement of the soil.

3.7 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.
   1. Trees in Turf Areas: Apply expanded shale mulch ring of 2-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within six (6) inches of trunks or stems.
   2. Expanded Shale Mulch in Planting Areas: Apply 2-inch average thickness of expanded shale mulch over whole surface of planting areas, and finish level with adjacent finish grades. Do not place mulch within three (3) inches of trunks or stems of shrubs.

3.8 MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION

A. Immediately begin maintenance after each plant is planted. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected until Substantial Completion. Tree turnbuckles and stakes shall be tightened and repaired as required. Defective work shall be corrected as soon as possible after it becomes apparent and weather and season permit. Settled plants shall be reset to proper grade and position, planting saucer restored and dead material removed.

B. Upon completion of planting, and prior to Substantial Completion, remove from site excess soil and debris and repair all damage resulting from planting operations.

C. As part of maintenance, provide protection and extermination measures against gophers, rabbits, or other rodents, and repair damage caused by their activities.

D. Adjust irrigation systems as required.

E. Do not prune without approval of the Landscape Architect.

F. 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.

3.9 MAINTENANCE DURING GUARANTEE PERIOD

A. Arrange a meeting with the Landscape Architect, the Owner and the Owner's designated maintenance personnel to review the approved maintenance program for the duration of the Guarantee Period.

B. Perform procedures set forth in the submitted and approved Maintenance Program for the duration of the Guarantee Period. The program based on the requirements of the Specification must be approved by the Landscape Architect and Owner.

C. Plants other than herbaceous material:
   1. Prune periodically, as necessary, to remove dead or damaged branches.
   2. Fertilizing
      a. Fertilize trees approximately one year after installation between October and December, or between February and April. Unless otherwise indicated by soil test results, mix specified fertilizer at the rate of 7 pounds to 100 gallons of water and apply by liquid injection method. Make insertion points approximately 2-1/2 feet apart, at a depth of 1 foot, applying 1 gallon at each insertion point. Applying fertilizer in the ball and backfill area, and to approximately 1 foot outside of the planting hole.
      b. Fertilize shrubs and ground covers with the specified fertilizer every three weeks between May 1 and August 1, unless otherwise indicated by soil test results. Apply at the manufacturer’s recommended dilution ratio, to achieve a total of 3 lbs. of actual nitrogen per thousand square feet of bed per year.
   3. Completely remove all weeds within mulch areas. Under no circumstances are weeds to attain more than two (2) inches of growth.
   4. Restore mulch and saucers around plants as necessary to preserve their appearance and to control weed growth. Total depth of mulch shall not exceed 4” and shall remain 6 inches from root flare.
   5. Water as necessary to keep the plant materials in their best condition. Coordinate schedules and procedures with Owner. Apply water slowly so as to penetrate the entire root zone.
   6. If any plant settles from its proper elevation, raise it to the proper level, do not merely fill in with additional material.
   7. Spray as necessary to control insects, fungus and other diseases. Continue spraying throughout the guarantee period.
   8. The Landscape Architect and Contractor will inspect the site to observe the completed Work, approximately three (3) months after the beginning of Guarantee Period. Contractor shall perform necessary remedial work immediately following inspection.

3.10 CLEAN UP AND DISPOSAL

A. Legally dispose of off-site all refuse and debris from these operations. Remove or neatly store material at the end of each day’s work. Burning of material or dumping on the site is prohibited.
   1. Maintain segregation of man-made materials, debris, organic matter, and soil material as may be required for conditions of disposal.
   2. Transport materials over legal haul routes and obtain necessary permits for transporting and disposal as required by Federal, State and local regulations.
   3. Removals at Completion: Remove all temporary preparation and protection measures installed on Project site at completion of Work and at a time approved by Landscape Architect.

B. Maintain the site in an orderly condition during the progress of Work. Continuously and promptly remove excess and waste materials; keep lawn areas, walks and roads clear. Store materials and equipment where directed. Immediately remove rejected materials from the property. Promptly remove equipment, surplus material, and debris and trash resulting from operations under this Contract upon completion and prior to initial acceptance of Work. Leave the site in a neat, orderly, "broom clean" condition.

END OF SECTION 329310

SECTION 329500 – GARDEN ROOF ASSEMBLY

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. Tray-type vegetated roof assemblies.
   2. Pregrown sedum mats.

B. Related Requirements:
   1. Division 32 Section "Exterior Planting"

1.3 DEFINITIONS

A. Captured Water: Water that is retained in the drainage layer of a vegetated roof assembly after new water additions have ceased and that cannot escape the roof except through evaporation or plant transpiration.

B. Finish Elevation: Elevation of finished growing-media surface of planting area.

C. Planting Area: Areas to be planted.

D. Plant; Plants; Plant Material: Vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

E. Growing Medium: Manufactured, lightweight soil mixture that promotes good growing conditions for specific varieties of plants.

F. FLL Greenroof Guidelines: German Guidelines for Planning, Execution, and Upkeep of Green Roof Sites, Current Release. Worldwide acknowledged state-of-the-art technology as scientific foundation for successful and thriving green roofs.

G. FM Approval: Class Number 4477, Approval Standard for Vegetated Roof System.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Arrange, in accordance with Division 01.
   2. Attendance: Contractor, Installer, Owner Architect, vegetated roofing system and membrane roofing system manufacturer representatives, roofing installer, and those requested to attend.

3. Meeting Date: Minimum 2 weeks prior to beginning work of this Section, and to prior work of related Sections affecting work of this Section.
4. Agenda:
   a. Discuss drainage mats, root barriers, filter fabrics, slip-sheets, protection course, and other requirements of the roofing manufacturer.
   b. Verify water source and connections for irrigation system.
   c. Discuss post-installation care including establishment period and maintenance regimen.

1.5 ACTION SUBMITTALS

A. Product Data: For each vegetated roof assembly.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include material descriptions for each growing medium.
3. Include material descriptions for each plant type and characteristics.

B. Shop Drawings: For each vegetated roof assembly.
1. Include plans, sections, slopes, and edger locations.
2. Indicate dimensions, weights, and loads.
3. Detail field assembly of components, metal edger connections, and attachments to other work.
4. Indicate walkway pavers, geofoam fill, locations of irrigation, coordination with lighting, and accessories.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer**.**
1. Written submittal by manufacturer indicating that installer is certified as qualified to perform the work of this section.

B. Product Certificates: For each type of manufactured product.
1. Manufacturer's technical data sheets for standard products.
2. Analysis of other materials by a recognized laboratory, according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Product Test Reports: For complete analysis of each growing medium, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency. Confirm that growing medium meets FFL Green Roof Guidelines.

D. Field quality-control reports.

E. Sample Warranty: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For vegetated roof assembly and plants, including a recommended maintenance plan with procedures for inspection and care during a calendar year. Submit before start of required warranty and maintenance periods.

B. Continuing Maintenance Proposal: From vegetated roof assembly Installer approved by roofing-membrane manufacturer to Owner, in the form of a standard two-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified vegetated roof assembly Installer, approved, authorized, or licensed by vegetated roofing system provider, whose work has resulted in successful establishment of vegetated roofs.
   1. Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when vegetated roof assembly work is in progress.

1.9 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. Store away from sources of ignition and extremely high temperatures. Avoid exposure to heat, sparks, and open flames,

B. Bulk Materials:
   1. Do not dump or store bulk materials on or near structures, utilities, walkways and pavements, or existing roof areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of debris-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Store growing medium in a dry area, free of contaminants which may adversely affect the engineered blend, including weed seeds.
   4. Accompany each delivery of bulk materials with product certificates.

C. Plant Materials:
   1. Maintain health of plants as recommended by nursery guidelines prior to installation. Store vegetated planters and materials over plywood panels or protective sheeting on the roof.
   2. Rolled sedum mats may be stored in a cool location, below 75 deg F, for a maximum of twenty-four hours. Do not leave plants in hot storage areas.
   3. Provide water source for irrigating plants per manufacturer's recommendations until permanent irrigation system is in place.

D. Handle and store materials, and place equipment in a manner to avoid overloading roof structure or damaging roofing membrane.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when optimum results may be obtained. Install plant materials when temperatures are between 40 deg F and 95 deg F, except as otherwise instructed by manufacturer. Do not install if extended freezing temperatures are expected or if ambient soil temperature is expected to remain below 50 deg F. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Manufacturer's Standard Full System Warranty: Limited warranty on materials: The manufacturer warrants to the Owner that all green roof "hard parts" supplied by the manufacturer will be free from defects in materials and workmanship for the warranty periods set forth below:
   1. Warranty Period: Twenty years, or the duration of the membrane manufacturer's warranty, whichever is less.

B. Extended Overburden Warranty for Vegetated Roof Assembly: Manufacturer will provide removal and replacement of vegetated roof assembly.
   1. Warranty Period: Twenty years, or the duration of the membrane manufacturer's warranty, whichever is less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain vegetated roof assembly components, growing medium, plants, and accessories from single source from single manufacturer.

2.2 VEGETATED ROOF ASSEMBLIES

A. Tray-Type Vegetated Roof Assembly: Modular assembly consisting of manufacturer's standard, planted-in-place trays for field assembly adjacent to and interlocking with each other over roofing system.
   1. Basis-of-Design Product: Provide Columbia Green Technologies Planted-in-Place Tray Green Roof System, no substitutions.
   2. Tray Depth, Nominal: 4-5/8 inches.
   3. Tray Size: 24 by 24 inches.
   4. Tray Material: Injection molded, 100 mil polypropylene, 88 percent post-consumer recycled content.
   5. Tray Design: Trays must be fully interlocking and overlap adjacent trays by a minimum of 1/4 inch. Tray bottom to have ridges and trough design to maximize air flow and retain stormwater.
   6. Connection Holes and Fasteners:
      a. Four 3/8 inch holes, aligned and centered in each vertical side panel.
      b. Plastic Tray Pin: Provided by manufacturer.
   7. Growing Medium Depth: Overfill trays to a minimum depth of 8 inches. Greater depth shall be provided in valleys of roof slopes to provide uniform surface elevation of growing medium.
   8. Assembly Weight: Maximum 52 lb/sq. ft, including growing medium and plants and saturated with captured water, but not including weight of roofing system.
   9. Recycled Content: Trays shall have post-consumer recycled content of not less than 88 percent.

2.3 MANUFACTURED GROWING MEDIA

A. Growing Media: Vegetated roof assembly manufacturer's lightweight, manufactured soil mixture designed for planted-in-place trays.

1. Basis of Design Product: Columbia Green Technologies; Intensive Growing Media.
2. General Condition at Time of Planting: Free of aggregates 1/2 inch or larger in any dimension; free of roots, plants, clods, pockets of sand, paint, building debris, oils, solvents, roofing materials, and other extraneous materials harmful to plant growth; free of weeds, disease-causing plant pathogens, and other undesirable organisms.
3. Maximum Media Density: ASTM E 2399, 85 lb/cu. ft. for growing-medium mixture.
4. Maximum Media Water Retention: ASTM E 2399, 35 to 65 percent by volume for growing-medium mixture at maximum media density per FLL Green Roof Guidelines.

2.4 PLANTS

A. Sourced and approved by Columbia Green Technologies for warranty to apply.

B. Conform to Project landscape design requirements, recommendations of local horticulturalists, and requirements of authorities having jurisdiction, including Fire Marshal, for specific recommendations and regulations.

C. Pregrown Sedum Mat: 47 inch by 77 inch pregrown sedum mat with minimum 80 percent plant coverage.

D. Entire surface of green roof trays shall be planted with pregrown sedum mats, followed by plugs inserted through the sedum mats, into the growing medium.

2.5 ACCESSORIES

A. Protection Board: As recommended by roofing-membrane manufacturer.

B. Soil Retainer: Vegetated roof assembly manufacturer's formed stainless-steel edging.
1. Basis-of-Design Product: Columbia Green Technologies Standard Tray Edger
2. Tray Edger: 8.5” x 7.5” 26 gauge aluminum with prefabricated tray pin receiving slot for tray attachment. Manufacturer’s 8” metal plate shall be used to extend height of edger in valleys of roof slopes in order to maintain consistent elevation for top of edger. Metal plate is screwed to edger with stainless steel screws at each end and at 18” o.c. for length of each plate.
   a. Color: Mill finish.
   b. Corners: Provide manufacturer's Prefabricated Standard Tray Edger Inside Corner and Prefabricated Outside Corner at 90 degree corners. Match color to tray edger.
3. At perimeter trays, cut trays and trays adjacent to roof drains, install filter fabric within trays and extend up to top of edger and/or metal plate extension of edger to prevent growing medium from filtering out between tray and edger.
4. Method of Attachment, Tray System: Tray edger is held in place to surface of roof by the weight of the system. Use manufacturer's standard removable pin fastener to attach edger to sides of tray.

C. Roof Drain Box & Lid: Provide (2) 24”x24”x8”HT. per pair of roof drains by Columbia Green. Alternatively, a single 24”x48”x8”HT. box & lid may be substituted for each pair of roof drains. Surround and cover drain box and lid with 2” diameter smooth river rock to meet the surface elevation of the adjacent edger and growing medium.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine each area to receive vegetated roof assembly for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Verify that roof insulation over roofing membrane is in place, secure, and flush along all seams.
   2. Verify that perimeter and other flashings are in place and secure along entire lengths where they will be covered by vegetated roof assembly.
   3. Verify protection course over membrane roofing is in place and conforming to roofing manufacturer instructions, as inspected and accepted by roofing manufacturer's technical representative.

B. Inspect growing medium.
   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 growing medium within a planting area.
   2. If growing medium is contaminated by foreign or deleterious material or liquid, remove growing medium and contamination and replace with new growing medium.

C. Install growing medium in trays. Growing medium shall fully fill all trays and shall be mounded above top of trays to the top of edger and at the interior of large areas, in order to provide a consistent surface elevation and eliminate the slopes resulting from the trays being placed on variable slopes of the roof beneath.

3.2 INSTALLATION, GENERAL

A. Protection Course: Cover roofing system with protection board if required by roofing manufacturer with butted and fully taped joints before roofing system is subject to vegetated roof assembly installation work.

B. Sweep with broom and then use air compressor to blow remaining dust and debris from substrate.

C. Install vegetated roof assembly according to manufacturer's written instructions. Install trays, locking all trays to adjacent trays with pins. Install edger and metal plate extension around entire perimeter of green roof limits, as well as around roof drains. Install roof drain boxes and lids and surround/cover with river rock. Install irrigation supply through trays extend and piping to valve box locations. Install filter fabric at all locations where growing medium could escape between trays/edger, cut trays, pipe penetrations, etc.

3.3 TRAY PLACEMENT

A. Install trays according to manufacturer's written instructions and details.

B. Place trays directly over protection cover provided under roofing work.

C. Position bottom troughs of trays perpendicular to direction of roof slope, except minor crickets.

D. Orient and overlap interlocking sides to hold trays in place.

3.4 TRAY EDGER & ACCESSORIES INSTALLATION

A. Install edger according to manufacturer's written instructions and details.

B. Install tray edger at vegetated roof perimeter to conceal tray sides and define limits of river rock around roof drains.

C. Place short end of edging under tray so that it is held in place by weight of tray.

D. Abut lengths of edging neatly. Allow 1/8 inch gap maximum between edging sections. Adjust and trim edging to align sections and achieve a tight fit.

E. Screw 8” ht. metal plate to top of edger in order to raise the top edge to a consistent height where the roof valleys occur. Edger and metal plates come in 8’ lengths and must be trimmed to fit the peaks and valleys of the roof. Stainless steel screws shall be used to secure the metal plate to the edger at each end and at 18” intervals in between.

F. Corners: Utilize manufacturer's prefabricated corners.

G. Install filter fabric at perimeter of tray system to the top of the edger in order to prevent loss of growing medium leaking between them. Install filter fabric at cut trays and secure it snuggly around pipe penetrations through trays to prevent loss of growing medium.

H. Install roof drain boxes and lids over pairs of roof drains. Surround and cover with river rock to height of adjacent edger and growing medium.

I. Install irrigation piping, wiring and valves in valve boxes. Install drip lines and all components of irrigation system.

J. Install pregrown sedum mats and plant plugs through the mats.

3.5 ADJUSTING

A. Make adjustments and alignments of trays and metal edger as necessary to give a uniform and finished appearance.

B. Replace plant material that appears to be stressed or damaged.

3.6 CLEANING

A. Leave installations clean, premises free from debris and residue resulting from work of this Section.

B. Remove stains from adjacent surfaces with manufacturer's recommended cleaning agents.

3.7 PROTECTION

A. Protect vegetated roof assemblies from damage, including growing-medium contamination, due to operations of other contractors and trades. Repair or replace damaged vegetated roof assemblies.

3.8 MAINTENANCE SERVICE

A. Maintenance Service: Provide maintenance by skilled employees of vegetated roof assembly Installer approved by roofing-membrane manufacture**r**. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than the specified maintenance period.
   1. Assembly and Plant Maintenance: During maintenance period, maintain plantings by pruning, cultivating, watering, weeding, fertilizing if necessary, mulching, restoring planting saucers, adjusting and repairing devices, resetting plants to proper elevations 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.
      a. Replace growing medium that becomes displaced or eroded because of settling or other processes.
      b. Apply treatments as required to keep plant materials, planted areas, and growing medium free of pests and pathogens or disease. Use integrated past 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.
      c. Use only products and methods acceptable to roofing-membrane manufacturer.
      d. Following maintenance period, instruct Owner and furnish written maintenance instructions as necessary for planting materials to develop and maintain healthy root structure.
   2. Maintenance Period: 24 months from date of Planting Completion.

END OF SECTION 329500

SECTION 33 0101

SEWER AND DRAIN PIPE

PART 1 GENERAL

1.01 SUMMARY

A. All pipe and accessories supplied for use on this project shall be as specified herein.

B. All pipe supplied for this project shall be of the pipe material called for on the Drawings.

1.02 RELATED WORK

A. For bedding and backfill stone see Section 321123.

1.03 REFERENCES

A. Where referenced specifications (ASTM, AWWA, etc.), are mentioned, these standards are deemed to be the minimum standard of quality of materials or methods to apply to this project.

1.04 SUBMITTALS

A. Copies of the manufacturer's directions for handling and installing the particular pipe supplied and accepted by the ENGINEER shall be furnished to the ENGINEER at the first delivery of pipe to the project in numbers that will permit the ENGINEER to retain 3 copies.

B. The manufacturer's instructions shall be strictly followed unless a conflict exists between the manufacturer's instructions and those contained herein. In such cases, the ENGINEER shall determine which methods are to be followed and no pipe shall be installed until the CONTRACTOR has received written instruction from the ENGINEER as to which procedure to follow.

1.05 QUALITY ASSURANCE

A. Where pipe enters manholes, the pipe manufacturer shall certify that their pipe is compatible with the watertight, flexible seal to be used at manhole openings as specified in Section 330513 of these Specifications, and that their combined use will produce a flexible watertight installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All pipe, fittings and jointing materials shall be of one manufacturer unless different types are shown on the Drawings or otherwise accepted by the ENGINEER.

2.02 MATERIALS-SEWER AND DRAIN PIPE

A. Sewer Transition Joints

1. Where sewer pipes of different materials are to be joined, i.e., VC pipe to DI pipe, VC pipe to PVC pipe, or some other combination, an adapter made for this purpose shall be used. The adapter shall be made of polyurethane or polyvinyl chloride with stainless steel clamps and shall be equal to Can-Tex C-T Adapter, Can-Tex Industries, Cannelton, Indiana; or Fernco Adapter by Fernco Joint Sealer Company, Ferndale, Michigan.

B. PVC (Polyvinyl-Chloride) Sewer Pipe

1. Pipe

a. PVC pipe 4-inch through 15-inch diameter supplied for use on this project shall be Type PSM Polyvinyl Chloride (PVC) Sewer Pipe as specified per ASTM D 3034. PVC pipe 18-inch through 27-inch diameter shall be as specified in ASTM F 679.

b. The pipe shall be made of PVC plastic having a cell classification of 12454 as defined in ASTM D 1784. Compounds having different cell classifications due to one or more properties being superior to those of the specified compound are acceptable. Clean rework material, generated from the pipe manufacturer's pipe or fittings production may be used by the same manufacturer provided the reworked products meets the requirements stated herein.

c. The pipe shall be homogeneous throughout, free of cracks, holes, foreign inclusions or other injurious defects. The pipe shall be uniform in color, wall thickness, density and other physical properties. The maximum laying length for all PVC pipe supplied shall be 13.0± feet. Wall thickness shall be SDR-35 per ASTM D 3034 or ASTM F 679. Marking and identification of pipe shall be per ASTM D 3034 or ASTM F 679 as applicable.

d. The maximum laying length for all PVC pipe supplied shall be 13.0± feet.

e. PVC pipe for use on interior piping shall meet the general specification for exterior piping with the socket dimensions conforming to Table 4 of ASTM D 3034.

2. Fittings

a. PVC fittings supplied for use on this project shall meet all the physical and quality requirements as hereinbefore specified for PVC pipe.

b. Where 90° bends are used, they shall be the long radius type.

c. PVC fittings for 4-inch through 15-inch diameter pipe shall meet the dimensional requirements of the tables as shown in ASTM D 3034 except that saddle type wyes or tee branches shall not be allowed for use on new sewer mains. Where 90° bends are used, they shall be the long radius type. PVC fittings for 15-inch through 27-inch diameter pipe shall conform to the requirements of ASTM F 679.

3. Joints - Exterior Piping

a. Joints for PVC pipe and fittings for sewer mains and exterior plant gravity sewers shall be of the "Push-On Type" composed of an elastomeric ring gasket compressed in the annular space between a bell end or socket and spigot end of the pipe.

b. All surfaces of the bell, socket or spigot end of the pipe against which the ring gasket may bear shall be smooth, free of cracks or other imperfections that could adversely affect the sealing capacity of the joint.

c. Lubricant for use in assembling joints shall be supplied with the pipe or be of the specific manufacturer as recommended by the pipe manufacturer for use with the specific pipe supplied. The lubricant shall not cause deterioration of either the elastomeric ring gasket or pipe material.

d. Where PVC pipe and fittings are connected to piping of other materials, the manufacturer's standard adapters or transition pieces shall be used. Should manufacturer not produce an adapter for a specific pipe of other material, the adapters or transition fittings as specified in this section of these Specifications shall be used.

4. Joints - Interior Piping

a. Joints for PVC pipe and fittings for interior piping systems shall be the solvent weld type.

b. The solvent cement for use with PVC pipe and fittings shall be as specified in ASTM D 2564. The cement shall be provided with the pipe by the pipe manufacturer or be of a specific brand as recommended by the manufacturer of the pipe unless otherwise accepted by the ENGINEER.

C. Polyethylene (PE) Sewer Pipe

1. Pipe

a. Polyethylene pipe shall be manufactured from virgin polyethylene resins conforming to Type III, Class C, Category 5, Grade P34 polyethylene as defined in ASTM D 1248. Minimum cell classifications of the polyethylene material shall be 335433C as referenced in ASTM D 3350.

b. For determination of minimum wall thickness, the maximum allowable deflection is 5 percent, with the pipe installed in accordance with these Specifications. Calculations shall be based on backfill material of 130 pound per cubic foot, H-20 live load plus 50 percent impact and no internal pressure. The live load and impact may be disregarded for trenches with 8 feet or more cover. Hydrostatic loading shall be considered when the pipe is to be installed below permanent water table. The pipe manufacturer shall furnish calculations to verify the pipe wall thickness for these various conditions for the ENGINEER'S review before the materials are sent to the job site.

c. No cracks, holes, foreign materials, blisters or other deleterious faults are permitted in the polyethylene pipe. It shall be homogeneous throughout including the heat fused joint. Polyethylene pipe will not be installed containing gouges or cuts that penetrate more than 10 percent of the wall thickness.

d. Each length of polyethylene pipe shall be marked containing the manufacturer's name, pipe size and other data, as required by ASTM D 3350 to enable an accurate tracing of the raw material source.

2. Fittings

a. Polyethylene fittings for use on this project shall be fabricated from the same materials as specified herein for the pipe. Fittings shall meet the same quality standards as stated herein for the pipe and shall be from the same manufacturer as the pipe unless otherwise accepted by the ENGINEER.

b. Branch fittings for lateral pipes shall be made using wye or tee branches. Sidewall fused connections using pipe manufacturer's

recommended procedures are also acceptable. Saddle type branches for use on new polyethylene sewer lines will not be allowed.

3. Joints

a. Polyethylene pipe shall be joined by the heat fusion process. The pipe and joint (butt or sidewall fusion) shall be leakproof and all fusion must be performed by personnel trained by the pipe supplier or otherwise equally qualified person, as determined by the ENGINEER.

b. The fusion equipment shall have hydraulic controls and gauges for monitoring the fusion pressures and temperatures. The equipment shall have a motor powered facing unit to trim the irregularities of the pipe ends and an electrically or gas-fired heated and thermostatically controlled heater plate capable of producing fusion temperatures as recommended by the pipe manufacturer for the particular polyethylene extrusion used on the project.

c. Threaded or solvent weld joints and connections are not permitted. The manufacturer's standard adapters shall be used to connect polyethylene pipe to other types of non-pressure pipe.

d. Where joints must be made in the ditch, and conditions are such that use of the fusion machine is impossible, a stainless steel coupling may be used, if accepted by the ENGINEER.

e. Where pipe enters manholes, the pipe manufacturer shall certify that their pipe is compatible with the watertight, flexible seal to be used at manhole openings and that their combined use will produce a flexible watertight installation.

D. Ductile Iron Sewer Pipe

1. Pipe

a. This specification covers 4 to 64-inch ductile iron gravity sewer pipe designated "DI" on the Drawings. Pipe furnished under this Specification shall comply with all provisions of ANSI/ASTM A 746. Maximum design thickness shall be based on depth of cover, trench loadings and other conditions per ANSI/AWWA C150/ A21.50.

b. Metal Design Strength psi (Minimum)

Tensile Strength	60,000
Yield Strength	42,000
Percent Elongation	10

c. The net weight, class or nominal thickness, and casting period shall be shown on each pipe. The manufacturer's mark, the year in which the pipe was produced, and the letters "DI" or "DUCTILE" shall be cast or stamped on the pipe.

2. Fittings

a. Fittings for ductile iron sewer pipe shall be mechanical joint or rubber ring slip joint fittings.

b. Ductile iron mechanical and rubber ring slip fittings shall conform to ANSI/AWWA C110/A21.10 for gray iron and ductile iron fittings. Mechanical joints and rubber slip ring joints shall also conform in all respects to ANSI/AWWA C111/A21.11 and ANSI/AWWA C 153.

c. All fittings shall be manufactured for the size and pressure class of the pipeline in which they are to be used. All fittings shall be furnished complete with all joint accessories.

3. Joints

a. General

(1) Pipe joints shall be mechanical joint, rubber ring slip joint or restrained joint as shown on the Drawings.

(2) All items used for jointing pipe shall be furnished with the pipe. The joints shall be made with tools and lubricant in strict conformity with the manufacturer's instructions. Copies of the instructions shall be delivered to the ENGINEER at start of construction in sufficient numbers that will permit the ENGINEER to retain 3 copies.

b. Mechanical Joints

(1) Mechanical joints are to be furnished according to ANSI/ AWWA C111/A21.11-95. All pipe joints must be furnished complete with all accessories. Mechanical joint bolts and nuts shall be of alloy cast iron or alloy steel (Corten type such as U.S. Alloy) or equal. Rubber gaskets shall be made of plain first grade rubber, free of imperfections and porosity. Hardness shall be 70 to 75 durometer.

c. Rubber Ring Slip Joint (Push On)

(1) Rubber ring slip joint shall be equal to ANSI/AWWA C111/ A21.11-95. The joints shall be of the following materials and assembled in the sequence outlined below:

(a) Rubber ring gasket compressed in groove in bell of pipe.

(b) Beveled spigot end of pipe for initial centering into rubber gasket in bell.

d. Restrained Joints

(1) For Pipe

(a) Restrained joint for push-on type bell with rubber O-ring shall meet the applicable requirements of ANSI/AWWA C111/A21.11. The bell/spigot configuration for the restrained joint shall be such that restraint shall be provided for the joint based on a sustained pressure equal to the pressure class of the pipe without separation.

(b) The restrained joint shall allow the same deflection as standard push-on joint pipe.

(c) Where field welding is required for restrained field cut pipe, the welder shall be properly instructed in the methods and materials for use on ductile iron pipe by the manufacturer, on site.

(2) For Fittings

(a) Where restrained joint fittings are called for, the bell configuration for the fitting shall be the same as for the pipe.

(b) Where fittings with restrained joint bell configurations are not available, restraint materials for use with mechanical joint bell configurations shall be as follows:

(i) Connect mechanical joint bell assemblies with stainless steel, all thread rods.

(ii) Install restraint glands on each side of the fitting. The restraining glands shall be “Meg-A-Lug,” as manufactured by EBAA Iron sales, Inc. of Eastland, Texas; “Grip Ring,” as manufactured by Romac Industries, Inc. of Seattle, Washington; or equal.

4. Coating and Linings

a. All ductile iron pipe and fittings for gravity sewer service shall be bituminous coated outside in accordance with ANSI/AWWA C151/ A21.51 for pipe and ANSI/AWWA C110/A21.10 for fittings.

b. All ductile iron pipe and fittings for gravity sewer service shall be cement-mortar lined with seal coat in accordance with ANSI/AWWA C104/A21.4.

E. Underdrain Pipe

1. Pipe

a. Underdrain pipe and fittings shall be of the sizes, with and without perforations, as indicated on the Drawings.

b. Pipe shall be polyvinyl chloride (PVC) pipe, Type S, as follows:

(1) Smooth—Conform to ASTM D 1785 for Schedule 40, or ASTM D 2241 for SDR-17.

(2) Ribbed—Conform to ASTM F 794 for Series 46.

(3) Corrugated—Conform to ASTM F949.

c. Manufacturer shall certify to ASTM requirements.

2. Fittings and Couplings

a. Couplings for perforated pipe shall be the flexible plastic type and couplings for unperforated pipe shall be watertight, standard couplings with solid rubber rings. All fittings and couplings shall be as recommended by pipe manufacturer.

2.03 SOURCE QUALITY CONTROL

A. PVC Polyvinyl-Chloride Sewer Pipe

1. Pipe shall be tested and inspected at the factory and inspected at the job site. Testing shall be accomplished in conformance with the following ASTM specifications utilizing the test methods specified therein:

Dimensions	ASTM D 3034 or ASTM F 679 and D 2122
Extrusion Quality	ASTM D 2152
Pipe Stiffness (5%)	ASTM D 2412
Impact Resistance	ASTM D 2444

2. In addition, a typical joint assembly, both gasket type joint and solvent weld joint, shall be tested by a qualified independent laboratory per test requirements of ASTM D 3212. The manufacturer shall submit through the CONTRACTOR sufficient copies of certification and test results for each lot of material represented by shipment to the job site that will permit the ENGINEER to retain 3 copies.

B. Polyethylene (PE) Sewer Pipe

1. All polyethylene pipe and materials shall be tested by the manufacturer of the pipe using the following referenced ASTM methods and procedures:

Density	ASTM D 1505
Flow Rate	ASTM D 1238
Flexural Modules	ASTM D 790
Tensile Strength	ASTM D 638
Stress Crack Resistance	ASTM D 1693
Hydrostatic Design Basis	ASTM D 2837
Thermal Stability	ASTM D 3350
Carbon Black Content	ASTM D 1603

2. Results of tests on the raw materials and the polyethylene pipe shall be furnished along with catalogs and other descriptive literature, in sufficient copies for the ENGINEER'S review before the materials are sent to the job site that will permit the ENGINEER to retain 3 copies.

3. Polyethylene pipe and fittings may be rejected for failure to meet any of the requirements of this specification.

C. Ductile Iron Pipe (Mechanical Joint and Rubber Slip Joint Type)

1. Hydrostatic and physical acceptance tests shall be in accordance with ANSI/AWWA Specification C151/A21.51-81 for ductile iron pipe centrifugally cast in metal molds or sand lined molds for water or other liquids.

2. The ENGINEER shall be provided with sufficient copies of each of the tests for each Contract to permit the ENGINEER to retain 3 copies.

3. All items used for jointing pipe shall be tested before shipment.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION-SEWER AND DRAIN PIPE

A. General

1. All excavation shall be open trenches, except where the Drawings call for tunneling, boring, or jacking under structures, railroads, sidewalks, roads or highways.

B. Trees and Shrubs

1. Trenching shall include all clearing and grubbing, including all weeds, briars, trees, and stumps encountered in the trenching, regardless of size. The CONTRACTOR shall dispose of any such material by burning, burial or hauling away or as noted on the Drawings, at no extra cost to the OWNER. Ornamental shrubs, hedges, and small trees (3 inches in diameter or less) shall be removed, protected, and replanted, at no extra cost to the OWNER.

2. Where pipelines run through wooded terrain, cutting of trees within limits of maximum permissible trench widths, as set forth in this article, will be permitted. However, cutting of additional trees on sides of trench to accommodate operating of trenching machine will not be permitted. The CONTRACTOR shall obtain specific permission of the OWNER before cutting any tree larger than 4 inches in diameter.

C. Highways, Streets and Railroads

1. Trenching also includes such items as railroad, street, road, sidewalk, pipe, small creek crossings, cutting, moving, or repairing damage to fences, poles or gates and other surface structures, regardless of whether shown on the Drawings.

2. The CONTRACTOR shall so coordinate his work as to produce a minimum of interference with normal traffic on highways and streets. He may, with the approval of the governing agency, close a street to traffic for such length of time considered necessary, provided persons occupying property abutting the street have an alternate route of access to the property which is suitable for their needs during the time of closure. It shall be the responsibility of the CONTRACTOR to give 24 hours advance notice to fire and police departments and to occupants of a street which will be closed, in a manner approved by the governing body.

3. Where located within city streets and/or roads, the opening of more than 200 feet of trench ahead of pipe laying and more than 100 feet of open ditch left behind pipe laying, before backfilling, will not be permitted, except upon written consent of the OWNER. Where located outside roadway or parking areas, longer distances for opening and closure may

be allowed provided the longer distance does not affect the safety of the general public. No trench shall be left open or work stopped on same for a considerable length of time. In case of objectionable delay trench shall be refilled according to backfill specifications.

4. Construction equipment will not be approved for use where treads are injurious to paving encountered. Curbs, sidewalks, and other structures shall be protected by the CONTRACTOR from damage by his construction equipment.

5. In case of damage to any existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structure will be in as good condition and serve its purpose as completely as before, and such restoration and repair shall be done without extra charge, except as set forth under the applicable provisions of the General Conditions.

6. Where trenching is cut through paving which does not crumble on the edges, trench edge shall be cut to at least 2 inches deep to straight and neat edges, before excavation is started, and care taken to preserve the edge to facilitate neat repaving.

7. The CONTRACTOR shall maintain road crossings in a passable condition for traffic until the final acceptance of the work, being paid only by unit price for crushed rock used, within limitations as hereinafter specified.

8. Railroad company and Department of Highways requirements in regard to trenching, tunneling, boring and jacking shall take precedence over the foregoing general specifications and the following tunneling and boring or jacking specifications, where they are involved. Where work is within railroad right-of-way, Railroad Protective Insurance shall be carried by the CONTRACTOR in the amounts required by the Railroad Company.

9. The insurance policy shall name the railroad as the insured and the original policy shall be delivered to the railroad after submitting same to the OWNER for review. The cost of flagmen required by the railroad and/or highway departments shall be paid by the CONTRACTOR.

D. Existing Utilities

1. The CONTRACTOR shall determine, as far as possible in advance, the location of all existing sewer, culvert, drain, water, electric, telephone conduits, gas pipes, and other subsurface structures and avoid disturbing same in opening his trenches. In case of sewer, water and gas services and other facilities easily damaged by machine trenching, same shall be uncovered without damage ahead of trenching machine and left intact or removed without permanent damage ahead of trenching and restored immediately after machine has passed, without extra cost to the OWNER.

The CONTRACTOR shall protect such existing facilities, including power and telephone poles and guy wires, against danger or damage while pipeline is being constructed and backfilled, or from damage due to settlement of his backfill. It shall be the responsibility of the CONTRACTOR to inform the customers of utilities of disruption of any utility service as soon as it is known that it has been or will be cut off.

2. Where there is the possibility of damage to existing utility lines by trenching machine, the CONTRACTOR shall make hand search excavation ahead of machine trenching, to uncover same, at no extra cost to the OWNER. Hand trenching is required, at no extra payment, where undue damage would be caused to existing structures and utilities by machine trenching.

E. Pipelines in Same Trench

1. Pipelines, force mains, and sewers laid in same trench shall, in all cases, be bedded on original earth, crushed stone, or other specified bedding materials, regardless of divergence in their elevations, unless otherwise specified. They shall never be laid in unsupporting backfill or one above the other. The CONTRACTOR shall receive applicable unit prices for each pipeline, force main, and sewer so laid, the same as if laid in widely separated trenches.

F. Location of Proposed Pipelines

1. The location of pipelines and their appurtenances, as shown on the Drawings, are those intended for the final construction. However, conditions may present themselves before construction on any line is started that would indicate desirable changes in location. Also, development of property traversed may require location changes. In such cases, the OWNER reserves the right to make reasonable changes in line and structure locations without extra cost, except as may be determined by the application of the unit prices bid to the quantities actually involved. The OWNER is under no obligation to locate pipelines so they can be excavated by machine.

G. Construction Stake-out

1. The ENGINEER will provide geometric base data for the CONTRACTOR'S use in locating sewers and facilities in the design location. The locations for vertical control (benchmarks) are shown on the Drawings with elevation and description duly noted. Each manhole, pumping station wetwell, or other notable sewage system component shall have the coordinates shown at the individual location or listed with the General Notes of the Drawings. It shall be the CONTRACTOR'S responsibility to locate the new facilities in their intended position using survey grade GPS survey equipment. It should also be the CONTRACTOR'S responsibility to

provide offset hubs at each manhole or such reference points as may be required to maintain the location of each new installation.

2. Where the CONTRACTOR elects to use grades (batter) boards for sewer construction, offset line and grade stakes shall be set and cut sheets prepared before trenching work is started. All stake-out work and cut sheet preparation shall be accomplished by the CONTRACTOR, the ENGINEER being responsible for review and checking the finished cut sheets. The CONTRACTOR shall provide all material, equipment, and labor for all stake-out work. Cut sheets, where required, shall be prepared on forms acceptable to the ENGINEER.

3. The cut sheets shall contain the following minimum information:

    a. Manhole stations

    b. Grade between manholes

    c. Centerline and offset stations

    d. Amount and direction of offset

    e. Centerline elevation

    f. Centerline cut

    g. Offset elevation

    h. Offset cut

    i. Average trench depth

    j. Utilities information and depths and/or any other pertinent information.

4. Where the CONTRACTOR elects to use grade (batter) boards for sewer construction, offset hubs shall be set perpendicular to each 25 foot centerline station. Where laser beam equipment is to be used, the offset line shall be as required for the specific type of laser equipment used. In either case, the CONTRACTOR shall be required to maintain at least the offsets at manholes until the sewer main has been constructed. The CONTRACTOR shall also, in either case, be required to obtain the original ground elevation along centerline, at each 25 foot station, for the purpose of calculation of the average trench depth.

5. Grades shown on the Drawings or as revised in the field are invert of pipe and NOT trench subgrade. The centerline cuts on the cut sheets shall have this calculation made, original ground surface to invert of sewer

pipe, which is the depth which shall be used for calculation of the average depth of trench and backfill.

H. Trench Requirements

1. All trenches must be dug neatly to lines and grades as shown on the Drawings, as established in the field and/or as established on the cut sheets. Trenches shall be of sufficient width to properly assemble or bolt joints.

2. Trenching shall be completed between one grade control point and the next in advance of the laying of pipe, where pipes, culverts, or other structures may be encountered whose grade cannot reasonably be determined ahead of trenching. Should the CONTRACTOR lay pipe closer to the opening of trench ahead, he shall bear cost of any removal and relaying which may be required to avoid location conflict.

3. The extra cost of trenching in difficult locations, such as stream, railroad, or highway crossing, if not covered by other Contract unit prices, shall be included in the unit price for furnishing, laying, trenching, and backfilling.

4. Where grade (batter) boards are used to establish finish grade, they shall be set by the CONTRACTOR, with at least 3 boards set at all times where installation is in progress. These will be set each 25 feet or less and will be set perpendicular to and spanning the centerline of the trench, such that the grade string is in the vertical plane of the pipe flow line. Grade boards shall be supported by stakes driven firmly on each side of the trench, unless otherwise acceptable to the ENGINEER. Where laser beam equipment is used, the setup shall be per the laser manufacturer's instructions and/or the permission of the ENGINEER.

5. Grades shown on the Drawings and/or profiles, cut sheets and offset stakes are the elevations of the invert of the pipe in all cases and excavation in open trench or tunnel must be made of sufficient depth to take care of required bedding of pipe and bells below these lines.

6. No additional compensation will be allowed for the extra depth trenching so required below invert.

7. Where bottoms of trench for 6-inch through 16-inch size pipe are in or on solid rock or where concrete cradle or arch is to be used, trenches or tunnels shall be dug to a depth of at least 6 inches below bottom of barrel of pipe. Where in earth, they shall be dug to at least 4 inches below bottoms of pipe barrels and bells.

8. In pipe sizes 18-inch through 72-inch, the trench shall be dug to a depth of 1/4 of the outside diameter of the pipe below the bottom of the pipe barrel in earth or solid rock subgrade, with a maximum of 9 inches, and a

minimum of 6 inches. This requirement shall also apply where concrete arch or cradle is used to protect the pipe.

9. When trench or tunnel is dug below required grade, the pipe must be brought to grade by filling with crushed rock for pipe bedding as specified in this Section 321123 of these Specifications, at the CONTRACTOR'S expense. Fill for pipe support shall not be made with material excavated from trench.

I. Excavation Unclassified

1. Excavation for pipelines shall be unclassified and the cost of all excavation of whatever nature and state, including solid rock, shall be included in the CONTRACTOR'S unit price bid for furnishing, trenching, laying and backfilling the pipe.

2. Excavation for structures such as manholes, pump stations, and vaults is likewise unclassified and the cost of all excavation of whatever nature and state, including solid rock, shall be included in the CONTRACTOR'S lump sum or unit price bid, as the case may be.

3. Solid rock is defined as materials of one-third cubic yard or more in one location (in a native state or concrete) that rings under the hammer which cannot be removed economically without the use of explosives. Paving removal is excluded; also shale rock.

4. In the event the ENGINEER finds it necessary to specifically order mechanical removal of solid rock, it will be measured by the cubic yard for such materials actually removed limited in depth to required depths of bedding below outside of pipe barrel and in width to the following dimensions:

TABLE 3.01

For 6" Pipe 2'-6"	For 15" Pipe 2'-10"	For 27" Pipe 4'-0"
For 8" Pipe 2'-9"	For 16" Pipe 2'-11"	For 30" Pipe 4'-4"
For 10" Pipe 2'-9"	For 18" Pipe 3'-2"	For 33" Pipe 4'-7"
For 12" Pipe 2'-9"	For 20" Pipe 3'-5"	For 36" Pipe 5'-6"
For 14" Pipe 2'-9"	For 21" Pipe 3'-6"	For 42" Pipe 6'-0"
	For 24" Pipe 3'-8"	For 48" Pipe 6'-6"
		For 54" Pipe 7'-0"

5. Mechanical removal of solid rock is defined as solid rock in its native state which is ordered to be fractured and broken up for removal by hand tools and/or hand held power or pneumatic tools to provide protection of utilities, structures, etc. which might otherwise be subject to damage by conventional drilling and shooting or heavy excavating equipment.

6. Payment for mechanical removal will not be authorized for solid rock excavation which is accomplished by drilling and shooting or by crawler or wheel mounted excavators, trenching machine, and similar equipment.

J. Dewatering of Trenches

1. Dewatering of trenches shall be considered a part of trenching, at no extra cost to the OWNER. Dewatering of trenches shall include ground-water and storm or sanitary sewage. Suitable pumping and other dewatering equipment is to be provided by the CONTRACTOR, to insure the installation of the pipeline structure in a dewatered trench and under the proper conditions. Dewatering shall include all practical means available for prevention of surface runoff into trenches and scouring against newly laid pipe.

2. Piles of excavated materials shall be trenched or temporarily piped to prevent, as far as practical, blockage of drainage ditches and gutters, and water carriage of excavated materials over street and highway surfaces.

3. Where subgrade of trench has insufficient stability to support the pipeline and hold it to its original grade, the ENGINEER may order stabilization by various means. Exclusive of dewatering normally required for construction and instability caused by neglect of the CONTRACTOR, it shall be paid for at unit prices set up in the Contract, such as extra excavation, crushed rock for pipe bedding, concrete cradle or piling.

3.02 LAYING SEWER PIPE

A. General

1. Checking of Pipe

a. The selection of pipe strength class shall be based on earth weight of 130 pounds per cubic foot and a safety factory of 1.50.

b. All pipe and fittings must be tested for uniform diameter, straightness, and defects by the CONTRACTOR before being lowered into trench, and rejected pipe marked in a way not to impair its value. Rejected pipe must be separated from accepted pipe and removed from the project. The ENGINEER will make periodic observations of pipe in storage and/or incorporated into the work. Pipe found defective, not meeting Specifications, or improperly installed shall be rejected and replaced.

2. Alignment and Grade

   a. All pipe, after being inspected and accepted, shall be laid to correspond with lines and grades staked out by the CONTRACTOR. All sewer lines shall be laid to constant grades between invert elevations shown on the Drawings. Grades shown on the Drawings are invert of pipe and NOT trench subgrade. The pipe lengths shall be fitted together and matched, so that they will form a sewer with a smooth and uniform invert, visible as a full circle from manhole to manhole, except in special cases where curved sewer lines are planned.

3. Unstable Subgrade

   a. In wet, yielding, and mucky locations where pipe is in danger of sinking below grade or floating out of grade or line, or where backfill materials are of such a fluid nature that such movements of pipe might take place during the placing of the backfill, the pipe must be weighted or secured permanently in place by such means as will prove effective. If crushed rock fill is necessary, it will be paid for per ton of such material used, except in cases where instability is caused by neglect of the CONTRACTOR.

4. Control of Quantities Laid

   a. Laying of pipe may be held up by the ENGINEER until trench has progressed far enough ahead to remove the possibility of having to change grade or alignment on account of other structures, pipelines, or conduits.

   b. Unless permitted or directed, not less than 100 feet of pipe shall be laid at one operation except for the following reasons:

      (1) Street and railroad crossings.

      (2) Wet caving trenches.

      (3) Business houses or institutions damaged by prolonged disconnection from street.

      (4) Less than 100 feet distance between manholes or pipe control sections.

5. Bedding of Pipe

   a. Six-inch through 16-inch pipe shall be laid with bottom quadrant of barrel and bells of pipe bedded in at least 4-inch depth of crushed stone when on earth subgrade and in at least 6-inch depth of crushed stone, below the bottom of the barrel of pipe when on

solid rock subgrade. Stone for bedding of 6 inch through 16-inch pipe shall be Kentucky Department of Highways Size 9 crushed rock as specified in Section 321123 of these Specifications, spaded into place. It shall be included in price for furnishing and laying pipe. Payment for the extra stone required for bedding pipe in solid rock for 6-inch through 16-inch pipe shall be included in the price bid for solid rock excavation in the case of classified excavation and in the price bid for trenching and backfilling in the case of unclassified excavation.

b. In case of pipe sizes 18-inch through 72-inch in both earth and solid rock trench, the subgrade shall be shaped to provide for a crushed stone pad, Kentucky Department of Highways Size 9, for a depth under the pipe barrel at least 1/4 the outside diameter of the pipe, with a minimum of 6-inch depth and a maximum of 9-inch depth. The bedding material shall be thoroughly spaded into place, in order to give a uniform bearing for at least the bottom quadrant of the pipe. Payment for such bedding shall be included in the price paid for trenching and backfilling or laying, even when in or on solid rock.

c. For PVC or polyethylene pipe, alternate bedding materials will be allowed with permission of the ENGINEER. In order to qualify for use with sewer pipes of these compositions, the bedding material must be of the type of material delineated as Class IA embedment materials per Table 1 of ASTM D 2321, namely, coral, slag, cinders, crushed stone or crushed shells. The alternate bedding materials must also be of the same gradation of the crushed stone previously specified, namely, Kentucky Department of Highways Size 9. The crushed stone previously specified shall be used for all other piping materials.

d. No filling of trench with earth to bring pipe to grade will be permitted. If trenches are dug too deep, they must be brought to grade and supported by crushed rock for pipe bedding (No. 9) as specified in Section 321123 of these Specifications at the CONTRACTOR'S expense. No pipe shall be laid in the trench until the subgrade is inspected and found correct.

6. Laying of Pipe (Mains)

a. Laying crew foreman shall direct subgrade preparation and plumbing and leveling invert of pipe to grade and line, the pipe layer following his directions in placing the pipe. The pipe layer will be responsible for pipe bedding, cleaning joint, proper placement of joint annular ring or gasket, tight jointing and homing pipe, securing pipe against settlement or other movement,

and inspecting and swabbing out any jointing material from inside of pipe.

b. No joints will be accepted that show leakage and, after backfilling and inspection, any joints are found that are allowing groundwater to enter the sewer must be excavated and repaired.

c. Plugs in branch fittings to future building sewers shall be protected from excavators by the method as shown on the Drawings for protecting the ends of laterals and shall be so constructed and joined in bell of pipe that they will be watertight, yet removable without breaking the bell or coupling when removed.

7. Laying of Branch Pipes and Laterals

a. Branch pipes shall be laid to serve the abutting property at points to be designated by the ENGINEER. Such pipes shall be connected to sewer main through tees or Y-branches of size of running sewer barrel and 6-inch side opening, with 6-inch 30 degree or 45 degree bends. Branch fittings in sewer and the connected bend, shall be supported from bottom of trench per standard details shown on Drawings.

b. At locations where the sewer is within street or road rights-of-way, house lateral pipes shall be laid to the property line or right-of-way line.

c. At locations where the sewer is within easement obtained by the OWNER, house lateral pipes shall be laid to the permanent easement line.

d. Branch tees or wyes for house laterals will be located during construction, regardless of where shown on the Drawings. House lateral location shall be at the convenience of the property owner or as directed by the OWNER and/or ENGINEER.

e. The end openings of house laterals shall be plugged with appropriate watertight plugs of permanent materials in the bell of the sewer lateral, removable without breakage of the pipe bell. Dead ends of sewers shall be plugged similarly.

f. Under normal conditions, where elevations are not critical, branch service sewers to customers shall be laid on not less than .01 foot per foot of length grade. Where elevations are critical, minimum grade shall be .005 foot per foot laid with batter boards or laser, same as specified for street sewers.

g. In the case of deep sewers, branch pipes may be brought up to a depth of approximately 5 feet below ground level with suitable bends and sewer pipe. These pipes shall be laid on a slant outside sewer trench, so they will be supported on original earth and not dragged down and cracked by backfill settlement.

h. In case of deep sewers in rock or narrow places, branch pipes shall be of cast iron soil pipe installed vertically per standard details of Drawings, with branch fittings in sewer main encased in Class 2,500 concrete. Payment for such concrete and forms above wye or tee branch shall be at the price bid per encasement.

i. All lateral sewers and branch pipes installed on this Contract shall have a detectable mylar tape placed in the backfill over and running with the lateral sewer. The tape shall be readily detectable employing the same type metal locators as used for the location of metal pipelines. The tape shall be green in color and have the words "CAUTION: BURIED SEWER LINE BELOW" printed on it. The tape shall be installed as shown on the standard details of the Drawings.

j. The tape shall be Type II, Detectable Mylar Marking Tape as manufactured by Line Guard, Inc. or equal. The cost of purchase and placement of the marking tape shall be included in the CONTRACTOR'S unit price bid for the lateral pipe and fittings.

8. Piping Connections at Structures

a. Lines

(1) Pipes shall be laid free from all structures other than manholes. Any pipe entering structures underground unsupported by original earth shall be supported by Class 3000 concrete, brick and mortar masonry, or Class 4000 concrete beams and columns as shown on detailed Drawings.

(2) Pipe shall be connected to manholes by fabricated manhole entry seals, specified in Section 330513 of these Specifications.

(3) Pipe stubbed out of manholes for future connections shall be plugged and tightly sealed with same jointing material used to plug laterals.

b. Plants

(1) Nonpressure pipes entering structures underground, unsupported by original earth for a distance of more than

3 feet shall be supported by Class 3000 concrete, where depth of such support does not exceed 3 feet. All pipes entering buildings or basins below original ground, which are more than 3 feet above structure subgrade and/or have a 3-foot span between wall and original earth, and have cover of more than 24 inches of earth or under roadway, shall be supported by concrete beams under them as shown on the Drawings with columns each 6 feet between structural wall and edge of excavation for the structure in order to prevent breakage from settlement of backfill about the structure. Concrete and reinforcing steel for such support are to be included in the lump sum portion of the Contract and not as extra concrete. Sewers entering structures shall have flexible joint within 16 inches of exterior of structure.

9. Protection of Pipe in Trench

   a. No walking upon the completed pipelines will be permitted until trench has been backfilled to a depth of at least 6 inches over the top of the pipe. The interior of the pipe shall, as the work progresses, be cleaned of all dirt, jointing materials, and superfluous materials of every description. When laying of pipe is stopped for any reason, the exposed end of such pipe shall be closed with a suitable plug fitted into the pipe bell, so as to exclude earth and other material, precautions being taken to prevent flotation of pipe by runoff into trench.

10. Observation of Pipeline

   a. No backfilling (except for securing pipe in place) over pipe will be allowed until the ENGINEER has had an opportunity to observe the joints, alignment and grade, in the section laid, but such observation shall not relieve the CONTRACTOR of further liability in case of defects occurring during or after placement of backfill.

B. Laying Sewer Pipe

1. PVC Pipe

   a. PVC sewer pipe laying shall comply with the requirements of ASTM D 2321 and the additional requirements of these Specifications and standard details of the Contract Drawings.

   b. Article 3.02.A of this Section 330101 shall apply to the installation of PVC sewer pipe. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. The bedding material shall conform to that specified in Article 3.02.A of this Section 330101.

c. All PVC sewer pipe shall be installed in a manner to limit deflection of the pipe to 5 percent. A deflection test shall be performed on all flexible pipe. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of 5 percent. If the deflection test is to be conducted using a rigid ball or mandrel, it shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

d. When laser equipment is being used for laying PVC sewer pipe, the CONTRACTOR shall provide adequate ventilation through the pipe to prevent distortion of the beams.

2. Polyethylene (PE) Sewer Pipe

a. PE sewer pipe laying shall comply with the requirements of these Specifications and standard details of the Contract Drawings.

b. Article 3.02.A of this Section 330101 shall apply to the installation of PE sewer pipe. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. The bedding material shall conform to that specified in Article 3.02.A of this Section 330101.

c. All PE sewer pipe shall be installed in a manner to limit deflection of the pipe to 5 percent. A deflection test shall be performed on all flexible pipe. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of 5 percent. If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

d. When laser equipment is being used for laying PE sewer pipe, the CONTRACTOR shall provide adequate ventilation through the pipe to prevent distortion of the beams.

e. One additional step in the installation of PE sewer pipe is required as the result of the fusion of the long lengths of pipe on the trench bank which produces a continuous pipeline without an open end where the invert elevation can be confirmed. Thus, it shall be necessary for the CONTRACTOR to carefully check the subgrade for the PE pipe, both for elevation and firmness at 5 foot intervals before installing the pipe in the trench.

f. Because of the high coefficient of expansion of polyethylene, this pipe shall not be sealed into manholes or walls of other structures until at least 48 hours have elapsed after backfilling the pipe to allow adequate time for the pipe temperature to stabilize.

3. Ductile Iron Sewer Pipe

a. Ductile iron sewers shall be laid in compliance with the requirements of these Specifications and standard details of Contract Drawings. Restrictions on depth of cover shall follow ANSI/AWWA C150/A21.50 requirements in Section 02610 for the various classes of ductile iron pipe. Joints shall be made with mechanical, restrained or rubber ring slip joint, according to the manufacturer's specifications and with tools recommended by them. A copy of the manufacturer's instructions shall be available at the site of work at all times when pipe is being laid. Joints shall be thoroughly cleaned and dry before pipes are laid in place.

b. Cutting of pipe may be done using methods as the CONTRACTOR may elect, but the CONTRACTOR will be held responsible for breakage or damage caused by careless cutting or handling.

c. No pipe shall be laid resting on rock, blocking or other unyielding objects, except where laid above ground on piers or in permanent tunnels. Exact lines and grades will be required on exposed pipelines placed on piers. Attachment of pipe to piers shall be as shown on the Standard Detail Drawings.

d. In permanent tunnels pipe shall be laid with bells resting on tunnel liner or on blocks just behind bells. After pipe has been adjusted to proper line and grade, a bedding of Class 3000 concrete shall be poured under pipe to support the entire bottom quadrant. Payment for such bedding shall be included in the unit price for tunnel liner.

3.03 TRENCH BACKFILL-SEWER AND DRAIN PIPE

A. General

1. Excavated materials from trenches and tunnels, in excess of quantity required for trench backfill, shall be disposed of by the CONTRACTOR. It shall be the responsibility of the CONTRACTOR to obtain location or permits for its disposal. Unit prices for furnishing and laying pipe, which includes trench excavation, tunneling, and backfill, shall include the cost of disposition of excess excavated materials, as set forth herein, with no additional compensation being allowed for hauling.

2. No extra charge shall be made for backfilling of any kind, except as herein specified. Backfilling shall be included as a part of the price for furnishing, laying, trenching, and backfilling. No extra charge shall be made for supplying outside materials for backfill except where fills above existing ground are necessary and payment is designated on the Drawings or in the Specifications. If backfilling of the trench or surface restoration is not properly completed, a proportionate part of the unit

price for furnishing, laying, trenching, and backfilling shall be retained from payment estimates.

3. Railroad company and Department of Highways requirements in regard to backfilling will take precedence over the above general Specifications where they are involved.

4. Mechanical tamping, where required by the ENGINEER in locations other than those specifically designated herein, shall be paid for per unit price bid for mechanical tamping.

5. Before completion of the Contract, all backfills shall be reshaped, holes filled, surplus materials hauled away, all permanent walks, street, driveways, highway paving replaced, and all sodding, seeding, and planting work performed.

B. Haunching

1. Upon completion of bedding and laying the sewer or drain pipe, the CONTRACTOR shall place crushed rock, Kentucky Department of Highways Size 9 dependent on size of pipe, or the same material used for pipe bedding on both sides simultaneously to the top of the pipe. This material shall be hand placed using shovel or other satisfactory tool to work the haunching material completely under the bottom quadrant and around the sides of the pipe to assure the maintenance of alignment of the pipe. No compaction of this material is required other than that obtained by the workmen walking on the material during placement.

2. The haunching material is required for all sewer or drain pipe installed in open trenches except where concrete pipe arch is required, in which case the haunching material is required to the bottom of the arch. Where concrete cradle is required, the haunching material shall be placed from top of cradle to top of pipe.

3. The cost of furnishing and placement of the haunching material shall be included in the CONTRACTOR'S bid for furnishing and laying the pipe.

C. Initial Backfill

1. Upon completion of the haunching material to the top of the pipe, initial backfill shall be placed as hereby specified. This material shall serve as protection for the top of pipe reducing the possibility of damage to the pipe during the placement of backfill for the remainder of the trench depth.

2. When sewer or drain pipe is located outside traffic areas, the initial backfill material shall be crushed rock (Kentucky Department of Highways No. 9) placed above the pipe to the level hereinafter stated.

3. When the sewer or drain pipe is located within traffic areas, the initial backfill shall be crushed rock, or the material used for bedding and haunching the pipe, of the same gradation of the pipe bedding material. Other alternate materials may be used only with the specific written permission of the ENGINEER when the work is located inside traffic areas.

4. In the case of steel, cast iron, ductile iron pipe the initial backfill shall be hand placed to a point 6 inches above the barrel of the pipe. In case of plastic pipe, the initial backfill shall be hand placed and evenly spread to a point 12 inches above the pipe barrel for up to 4 feet cover, to a point 18 inches above the barrel for 4 feet to 10 feet cover, and 24 inches for over 10 feet cover.

5. The initial backfill material is required over sewer and drain pipe in all open trenches. The cost of the initial backfill material and placement of same shall be included in the CONTRACTOR'S bid for furnishing, laying, trenching, and backfilling.

D. Final Backfill

1. Outside Traffic Areas

a. After the above specified initial backfill is hand placed, rock may be used in machine placed backfill in pieces no larger than 8 inches in any dimension and to an extent not greater than one-half the volume of the backfill materials required to backfill trench. Larger rock fill will be allowed in wide trenches where side slopes are low enough to prevent rock from dropping over pipe-line. If additional earth is required, it must be obtained and placed by the CONTRACTOR. Filling with rock and earth shall proceed simultaneously, in order that all voids or pockets, created by rock backfill, may be filled with earth. Machine backfilling may be employed with tamping, except as hereinafter restricted, provided caution is used in quantity per dump and in uniformity of level of backfilling. Backfill material must be uniformly ridged over trench, and excess hauled away, with no excavated rock over 1/2-inch diameter or pockets of crushed rock or gravel in top 12 inches of backfill, the top 12 inches reserved for topsoil or material more suited to sustain surface growth. Ridged backfill shall be confined to the width of the trench and not allowed to overlap onto firm original earth, and its height shall not be in excess of that required to provide for settlement of backfill.

2. Inside Traffic Areas

a. Where sewer and drain pipe is located in street, highway, railroad, sidewalk and driveway crossings or within any roadway paving, or about manholes, valve and meter boxes located in such paving, fill

trench to within 6 inches of the surface with Kentucky Department of Highways No. 9 crushed stone, or other gradation acceptable to the ENGINEER. In order to accommodate compacted temporary surfacing it may be necessary to bulkhead or otherwise confine the stone fill at the open end of the trench.

E. Cleanup and Temporary Surfacing

1. General

a. Immediately following the placement of final backfill, all rock and debris, including crushed rock or gravel from construction operations, shall be removed from yards and fields. Streets, drives and walks shall be broomed to remove all earth and loose rock. The cleaning of streets, drives, and walks shall be of such extent to hold dust to a minimum. Loose earth and rock shall in no case be swept or washed into storm sewers or drains as a method of removal, all such material being loaded and hauled away from the site.

b. If acceptable cleanup operations are not completed within an acceptable period of time after the completion of final backfilling, a proportionate part of the price bid for trenching and backfilling shall be retained from partial payment estimates until acceptable cleanup is completed.

2. Temporary Surface Cover - Unpaved Areas

a. Upon completion of acceptable cleanup work, the ground surface shall be prepared for temporary seed, permanent seed or sod per the requirements of Section 329200 of these Specifications.

3. Temporary Surface Replacement - Paved Areas

a. Temporary surfacing of street, highway, railroad, sidewalk and driveway crossings, or within any roadway paving, or about manholes, valve and meter boxes located in such paving, shall consist of 6 inches compacted dense graded aggregate as specified under Section 321123 for temporary walkway or road surfacing, placed and compacted in the trench. Compaction shall be accomplished by methods which shall be sufficient to confine stone to the trench under normal traffic. Backfills shall be maintained easily passable to traffic at original paving level until acceptance of project or replacement of paving or sidewalks. The amount of crushed stone placed shall be paid for at the unit price per ton as shown in Section 330101 herein, titled "BASIS OF PAYMENT." No payment will be made for crushed rock surfacing required as a result of unnecessarily wide trenches, omission of

sheeting and shoring, or damage by the CONTRACTOR'S equipment, or for maintenance of surface level.

b. After the initial placement of the 6-inch depth of temporary surfacing, the CONTRACTOR shall be required to maintain the temporary surfacing to street or road surface level at no additional cost to the OWNER. This requirement shall continue until the replacement of permanent surfacing.

3.04 FIELD QUALITY CONTROL-TESTING SEWERS FOR LEAKS, INFILTRATION, AND DEFLECTION

A. Sewers

1. General

a. All sewers constructed under this Contract shall be tested for leaks and infiltration using methods as hereinafter specified.

b. The cost of all testing of sewer lines and manholes shall be included in the unit price bid for pipe and manholes. The CONTRACTOR shall furnish all materials, equipment and labor required for all types of tests, the ENGINEER being responsible only for directions, recording data and calculating air losses and/or infiltration rates.

2. Sequence

a. Initial Testing

(1) The first manhole to manhole section of sewer laid under this Contract, for each size of pipe and type of joint, shall be given a smoke test prior to the sewer being backfilled and while the sewer trench is dewatered to bottom of the pipe being tested.

(2) Should, based on the results of the test of the first section of pipe laid, the materials being used and the CONTRACTOR'S installation procedures prove to be satisfactory, subsequent smoke testing may, at the discretion of the ENGINEER, be waived. Should, however, based on the results of the test of the first section of pipe laid, the material being used and/or the CONTRACTOR'S installation procedures prove to be unsatisfactory, subsequent smoke testing shall, at the discretion of the ENGINEER, be continued until such time that, in the opinion of the ENGINEER, problems with materials and/or installation procedures have been corrected.

(3) Such subsequent testing shall likewise be done while trenches are dewatered to bottom of pipe to be tested and immediately after completion of either the public sewer lines or laterals, in not more than 2 sections between manholes at a time. All defective work, as so proven by the smoke test, shall be immediately repaired and retested until proven to be satisfactory.

(4) Observation of pipe laying and smoke testing shall in no way relieve the CONTRACTOR of the responsibility of conducting the required low pressure air test, infiltration tests, or correcting poor workmanship.

b. Subsequent Testing

(1) As soon as it is practicable after installing and backfilling sewers, and before putting new sewers into service, low pressure air tests shall be made from manhole to manhole, or up to a maximum of 500 feet of sewer main and 500 feet of sewer laterals at a time, as directed by the ENGINEER. The maximum allowance for air loss during testing shall be determined by tables of minimum holding time for a pressure drop of 1.0 psi and are based on an average loss of 0.0015 cubic feet of air per minute per square foot of internal pipe surface, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater present.

(2) Upon completion of installation and backfilling of all sewers constructed under this Contract, the low pressure air test is required for all sewers so constructed.

c. Additional Testing

(1) Upon completion of the required initial (smoke) testing and required subsequent (low pressure air) testing, and prior to placing the sewer into operation, if ground and/or surface water flow is observed in the completed sewer, the ENGINEER may order infiltration tests be accomplished to determine whether the flow is within acceptable and allowable limits. This additional testing may be required even though the results of the initial smoke testing and subsequent low pressure air testing indicate the sewers are substantially watertight. The infiltration tests shall be conducted, on order of the ENGINEER, as hereinafter specified.

3. Equipment

a. Smoke Testing

(1) The smoke testing blower shall have a capacity of at least 1,200 cfm.

(2) The smoke bombs shall produce a chemical reaction generated, white to gray smoke, leaving no residue, and be nontoxic and nonexplosive. Each bomb shall be capable of producing 25,000 cubic feet of smoke per 3 minutes.

b. Low Pressure Air Testing

(1) The air test equipment used shall meet the following minimum requirements:

(a) Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.

(b) Pneumatic plugs shall resist internal test pressures without requiring internal bracing or blocking.

(c) All air used shall pass through a single control panel.

(d) Three individual hoses shall be used for the following connections:

(i) From control panel to pneumatic plugs for inflation.

(ii) From control panel to sealed line for introducing the low pressure air.

(iii) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

4. Procedures

a. Safety Precautions

(1) The air test may be dangerous if a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of 25 lbs is exerted on an 8-inch plug by expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.

(2) As a safety precaution, pressurizing equipment shall include a regulator set at 10 psi to avoid overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

b. Low Pressure Air Test

(1) All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

(2) Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water.

(3) Plug all pipe outlets with suitable test plugs. Brace each plug securely.

(4) If the pipe to be tested is submerged in groundwater, insert a pipe probe by boring or jetting into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when the air passes slowly through it. This is the backpressure due to groundwater submergence over the end of the probe. All gauge pressures in the test shall be increased by this amount.

(5) Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

(6) After an internal pressure of 4.0 psig is obtained, allow at least 2 minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

(7) When pressure decreases to 3.5 psig, start stopwatch. Determine the time required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times for runs of single pipe diameter and for systems of 4-inch, 6-inch, or 8-inch laterals in combination with trunklines are indicated in the following table based on air loss calculations per ASTM F-1417.

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	7:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:42	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:36
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	35:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91;10	102.33
27	35:30	88	17.306 L	28:51	43:16	57:41	72:07	8l:32	100:57	115:22	129.48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	134:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193.53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

c. Infiltration Test

(1) Before putting new sewer lines into service, weir test shall be made of flow of water in the sewers from manhole to manhole or up to a maximum of 3,000-foot sections at a time, as directed by the ENGINEER. These tests shall be made when, in the ENGINEER'S judgment, groundwater level is equal to the highest groundwater condition in a normal year.

(2) The maximum allowance for all sewer pipe materials shall be 100 gallons per 24 hours per inch diameter per mile of sewer pipe and manholes.

d. Deflection Test

(1) A deflection test shall be performed on all flexible sewer pipe. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of 5 percent. If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices. Pipe deflection shall be measured and recorded by the CONTRACTOR in the presence of the ENGINEER using appropriate methods approved by the pipe manufacturer and acceptable to the ENGINEER.

5. Repairs and Acceptance

a. If the sewer fails to meet the requirements of the leakage and/or infiltration tests, the CONTRACTOR shall, at his own expense, determine the source of leakage and/or infiltration and make the necessary repairs or replacements.

b. If any sewer fails to meet the requirements of the deflection test, the CONTRACTOR shall, at his own expense, replace all failed pipe as necessary to comply with the deflection requirements. All replacement pipe shall also be tested for deflection.

c. On completion of sewer lines, all sewers and manholes will be inspected for foreign matter, including sand brought in by infiltration, and any such matter shall be removed before final acceptance of the lines. Any visible leakage at manholes or into lines shall be corrected regardless of the results of the required tests.

END OF SECTION

***

SECTION 33 0513

PRECAST CONCRETE SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. All items supplied for use on this project shall be as specified herein.

1.02 RELATED WORK

A. Concrete specifications are included in Section 033010.

B. Castings are specified in Section 055600.

C. Connecting piping is specified in Section 330101.

1.03 REFERENCES

A. Where referenced specifications (ASTM, ACI, PCI, etc.), are mentioned, these standards are deemed to be the minimum standard of quality of materials or methods to apply to this project.

1.04 SUBMITTALS

A. Shop drawings shall be submitted in accordance with Division 01.

1.05 QUALITY ASSURANCE

A. The precast fabricator shall be qualified in accordance with PCI MNL-116, Manual for Quality Control, for plants and production of precast concrete products.

1.06 DELIVERY, STORAGE AND HANDLING

A. Handle precast members in position consistent with their shape and design. Lift and support members only at such designated points.

B. .Provide temporary lateral support during storage as necessary to prevent bowing and warping. Temporary lateral devices shall be clean, non-staining and shall not inhibit uniform curing of exposed surfaces.

C. Protect edges of members from chipping or spalling.

D. Mark units with date of production and final position in structure.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete materials including cement, water, sand and coarse aggregate shall conform to ACI 301.

B. Reinforcing steel and prestressing wire and strand shall conform to ACI 301.

C. Initial Drawings shall be sent through the general CONTRACTOR to the ENGINEER in 3 copies for checking and return to the general CONTRACTOR in 2 copies.

D. Final Drawings shall be sent to the ENGINEER through the general CONTRACTOR in 5 copies for conformance and return in 3 copies.

2.02 PRECAST MANHOLES AND ACCESSORIES

A. Precast Reinforced Concrete Manhole Walls and Slabs

1. Precast reinforced concrete manhole walls and cone tops shall be of tongue-and-groove type conforming to ASTM C 478. Cone tops may be of concentric or eccentric configuration. Top slabs for manholes shall conform to details on the Drawings and to ASTM Designation C 478. All precast slabs shall be clearly marked "TRAFFIC" or "NONTRAFFIC" and "TOP" or "BOTTOM." Prior to use of precast reinforced concrete wall sections and top and bottom slabs, shop drawings covering details of construction including accessories shall be submitted to the ENGINEER for review.

2. Precast manholes with "knock-out panels**" for pipe entry are not acceptable**.

B. Manhole Adjustment Rings

1. Manhole frame adjustment rings shall be precast concrete rings for use between the top slab or top of cone and the manhole frame. Maximum allowable adjustment shall be 6 inches.

C. Mortar Materials

1. Portland Cement

a. Any standard brand, conforming to ASTM Specification C 150, Type 1, same as specified for concrete.

2. Sand

   a. First quality, clean, natural Kentucky River or Ohio River sand. When dry, 100 percent shall pass a No. 8 sieve and not more than 35 percent shall pass a No. 50 sieve, and conforming to ASTM Standard Specification C 144.

D. Preformed Elastic Rope Joint Fillers

1. Gasket-type sealant to fill tongue-and-groove joints at top of precast manhole bases and between barrel sections shall be preformed, flexible, watertight, designed for specific joint requirements and meet Federal Specification SS-S-00210 and AASHTO M-198. Sealant shall be Con-Seal manufactured by Concrete Sealants, Inc., New Carlisle, Ohio or Ram-Nek manufactured by K.T. Snyder Co., Inc., Houston, Texas, or equal. Primers, if required by manufacturer, shall be supplied by the sealant manufacturer.

E. Pipe Entry Seal

1. Pipes entering manholes shall be attached by a rubberized entry seal. The seal shall encircle the pipe snugly for the prevention of groundwater leakage into or sewage leakage out of the manhole. The seal shall be of the boot type with stainless steel clamps. The manufacturer of the seal shall certify that the seal material is compatible with the pipe material used on the project.

2. Boot seal shall be flexible of premolded EPDM (ASTM C 923) with stainless steel expanding snap-ring inserted into cored hole of manhole barrel and exterior stainless steel ring to clamp boot around pipe, Kor-N-Seal as manufactured by Trelleborg Engineered Systems, Milford, New Hampshire, or equal.

3. Where manhole is located in soils subject to petroleum or carbon materials, the pipe entry seal shall be of “nitrile” rubber material.

F. Steps

1. Manhole steps shall be cast into the manhole wall at intervals of not more than 15 inches where depths of manholes are greater than 4 feet unless otherwise shown on the Drawings.

G. Waterproofing Admixture

1. A waterproofing admixture such as Xypex Admix C-1000, Kryton KIM HS, or equal, shall be added to the concrete for manholes and wetwells during batching operations to provide waterproofing and improved chemical resistance. The Xypex Admix C-1000 or equal shall be added at 3.5 percent including dye to the required weight of Portland cement or as recommended by the admixture manufacturer. The amount of cement

shall remain the same and shall not be reduced on account of the addition of the waterproofing admixture. The colorant shall be added at the waterproofing manufacturing plant.

PART 3 EXECUTION

3.01 PRECAST MANHOLE CONSTRUCTION

A. General

1. Manhole construction will not be permitted under conditions where there is danger of freezing or when materials are frozen. Manholes shall be protected from freezing weather for a period of at least 48 hours after construction.

B. Excavation

1. Excavation for manholes, control chambers and interceptor structures shall be made of sufficient width to adequately accommodate all work and proper centering. Depth of excavation shall extend sufficiently to accommodate the type of manhole provided. Where a poured concrete base is used, the excavation must be of sufficient depth to allow for a minimum of 3 inches between the bottom of the lower pipe opening and bottom of manhole barrel and an 8 inch thickness for the poured concrete base. Where a precast concrete base is used, whether as a separate unit or integral with the bottom barrel section, the excavation shall be such to allow for a 12 inch depth crushed stone sub-base when in earth or a 9 inch depth crushed stone sub-base when in rock, below the bottom of the precast concrete base.

2. The cost for excavation of these structures is to be included in the linear foot price bid for trenching, backfill and structure unit price. Where the manhole subgrade is located in unstable material, the ENGINEER may order various methods of stabilization such as extra depths of crushed stone, concrete or other means as will prove effective. The CONTRACTOR will be paid for the extra work involved to stabilize the subgrade based on unit prices set up in the Contract unless instability is caused by the CONTRACTOR'S negligence. The limits for extra payment shall be from the elevation the CONTRACTOR would have had to complete based on the type of manhole base provided.

C. Manhole Installation

1. Manhole Base

a. Poured floor slabs of manholes shall be of Class 3500 concrete according to Section 03 3010, and shall be placed ahead of sewer laying to avoid displacement of sewer ends while placing concrete. The part of the concrete slab under the manhole walls shall have a smooth trowel finish. Top of slab shall be 3 inches (or as shown on

manhole details) below the lowest sewer invert grade. In sandy soils, a 6 mil polyethylene film shall be used under manhole slabs to prevent loss of moisture in concrete during placement.

b. Precast concrete base slabs will **be allowed based upon the ENGINEER'S** acceptance of the particular base slab provided. The general requirements for poured slabs shall also apply to precast slabs. Precast base slabs shall be placed on a crushed stone subgrade which has been leveled and compacted to the proper elevation. Crushed stone shall be DGA or Kentucky Department of Highways size 57 and shall be 12 inches in depth when on earth and 9 inches in depth when on solid rock.

c. Precast concrete manhole bottoms with accurately formed channels will be allowed as alternate to standard design, provided smooth surfaces and accurate levels, widths and slopes are obtained. The forms shall be constructed according to the angles and invert elevations obtained from the "stakeout" operation, and variation of forms more than ±2°00' horizontally shall be cause for rejection. Changes in angles or elevations of manhole inverts, caused by relocation of a manhole after the original stakeout, shall be the responsibility of the CONTRACTOR if such relocation is necessitated by conflict with water, gas, drain or other utility lines or obstructions. Placement shall be as detailed for precast slabs above.

2. Manhole Barrel

a. Manhole structure walls shall be constructed of precast concrete as shown on standard detail Drawings and as specified in this Section 330513. Barrels shall be accurately centered on the base slab as staked in the field.

b. When poured or precast concrete base slabs are used, the first barrel section shall be seated in and sealed with cement mortar. Intermediate barrel sections may be seated in and sealed with cement mortar or rope joint filler both as specified in this Section. Where rope joint filler is used, it shall be placed on the outside lip of the tongue and groove barrel section. Where a primer or adhesive is to be used with the rope joint filler, it shall be that specified by the joint filler manufacturer. Precast concrete frame adjustment rings and cast iron frame shall set in a full bed of cement mortar.

c. Precast barrel sections shall have steps cast in place or slots for steps left in place with steps to be located over the manhole outlet sewer pipe. Pipe openings shall be positioned to this arrangement. Likewise, eccentric corbel sections and precast top slabs with

offset entrance shall be positioned on center with the manhole steps over the outlet sewer pipe.

d. CONTRACTOR shall apply grout at all joints, to include joints between the manhole frame and the top of the manhole, in order to provide a smooth finished surface. Grout shall consist of 3 parts sand, 1 part Portland Cement, and sufficient water for hydration and placing.

3. Manhole Inverts

a. Channels through manholes shall be formed of either split tiles, prefabricated forms, or hand finished of the same size as the sewer pipes connected.

b. After the first barrel section has been set, the floor shall be brought up within 1 inch of the top of the sewer channels with crushed stone or broken brick ballast which shall be shaped to provide a slope of at least 3 inches from manhole sides to main sewer channels. One and one-half inches thickness of mortar proportioned by volume, 1 part Portland cement and 2 parts concrete sand in a damp, loose condition (80 pounds per cubic foot dry basis), shall be placed over the ballast. This shall be wood float finished to provide a smooth and well drained floor to the manhole channels.

c. The completed channels shall provide a smooth, steady transition between manhole inlet and outlet pipes. Any roughness or ragged edges within the completed channel shall be corrected prior to acceptance of the manhole.

d. CONTRACTOR shall apply grout around pipe inverts to provide a smooth finished interior surface in the manhole.

4. Manhole Drops

a. For joining sewer lines at different levels, drop manholes shall be provided. The drop inlets shall be as shown on the standard details of the Drawings.

D. Backfill

1. Backfill shall be accomplished per the requirements for sewer backfill as specified in Section 330101.

E. Vacuum Testing

1. General

a. All new manholes installed on this project shall be subjected to a vacuum test to determine the seal of all joints within the manhole. The vacuum test will not be required for existing manholes that are adjusted or partially reconstructed. The following test procedure is required for all new manholes:

(1) Lift holes shall be plugged with an approved nonshrinkable grout prior to testing.

(2) Drop connections shall be installed prior to testing.

(3) The manhole shall be finished and backfilled to design elevation prior to testing.

(4) The vacuum test shall include testing of the seal between the cast iron frame and top slab or cone section, slab, barrel sections, and/or grade rings.

2. Testing Procedure

a. Temporarily plug (and brace) all pipes entering the manhole at least 8 inches into the sewer pipe. The plug shall be inflated at a location beyond the manhole/pipe gasket.

b. The pressure gauge for the test hood shall be liquid filled, having a 3-1/2 inch face with scale reading from 0 to 30 inches of mercury.

c. The test head shall be placed inside the manhole frame and inflated according to the testing equipment manufacturer's recommendations.

d. A vacuum of 10 inches of mercury shall be drawn on the manhole. Upon reaching 10 inches of vacuum, close the valve on the vacuum line to the manhole and disconnect the vacuum line.

e. For the manhole to be considered as having passed the vacuum test, the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury must be equal to or greater than the following values, as referenced in ASTM C 1244:

Minimum Test Times for Various Manhole Diameters

Depth	Diameter, in.								
(ft)	30	33	36	42	48	54	60	66	72
	Time, s								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	39	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

f. Manholes failing the vacuum test shall be repaired with nonshrink grout or other suitable material and retested per the procedure shown previously.

g. All temporary plugs and braces shall be removed after each test.

h. The CONTRACTOR shall provide all equipment and labor required for vacuum testing of new manholes. The cost for this procedure shall be incorporated into the price bid for the manhole.

END OF SECTION

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SECTION 33 1100

WATER AND SEWAGE FORCE MAIN PIPE

PART 1 GENERAL

1.01 SUMMARY

A. All pipe, fittings, and jointing materials shall be of one manufacturer unless different types are shown on the Drawings or otherwise accepted by the ENGINEER.

1.02 SUBMITTALS

A. General

1. Prior to the shipment of any water and/or sewage force main piping to the project site, the CONTRACTOR shall submit to the ENGINEER a bill of materials, shop drawings, and descriptive literature for all piping, in the number of copies listed in Division 01 of these Specifications.

B. Plant and Site Piping

1. Submit shop drawings of all interior and exterior piping.

2. Submit testing and certifications for interior and exterior piping.

C. Water Main and Sewage Force Main Projects

1. Submit shop drawings for all piping.

2. Submit descriptive literature for all piping.

3. Submit testing and certifications for all piping.

PART 2 PRODUCTS

2.01 MATERIALS–WATER MAIN AND SEWAGE FORCE MAIN PIPE

A. Ductile Iron Pipe–Mechanical and Rubber Slip Joint Type

1. Pipe

a. General

(1) Ductile iron pipe shall be furnished for all piping 3 inches and over in size designated "DI" on Drawings and shall be designed in accordance with ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51 specifications and supplements thereto.

b. Design Conditions

(1) Pressure: Minimum 200 to 350 psi operating pressure, plus 100 psi water hammer allowance.

(2) Trench Loading: Laying Condition Type 3, depth of cover as shown on Drawings.

c. Metal Design Strength PSI (Minimum)

Tensile Strength	60,000
Yield Strength	42,000
Percent Elongation	10

d. Minimum Nominal Thickness

(1) Minimum design thicknesses for 200 through 350 psi operating pressures, depths of cover, trench loading and other conditions shall be per ANSI/AWWA C150/ A21.50 specifications.

e. Lengths

(1) Pipe may be furnished in 18 or 20 foot nominal laying lengths.

f. Marking

(1) The net weight, class or nominal thickness, and casting period shall be shown on each pipe. The manufacturer's mark, the year in which the pipe was produced, and the letters "DI" or "DUCTILE" shall be cast or stamped on the pipe.

g. Weighing

(1) Each pipe shall be weighed before application of lining or coating other than standard coating and the weight shown on the outside or inside of the bell or spigot end.

h. Spigot End of Pipe

(1) The spigot end of the pipe shall be free of blemishes and defects which, in the opinion of the ENGINEER, might be responsible for a poor fit with the rubber ring gasket and result in leakage.

2. Fittings

a. General

(1) Ductile iron mechanical joint, restrained joint and fittings shall conform to ANSI/AWWA C110/A21.10 Standard for Gray Iron and Ductile Iron Fittings – 3 inches through 48 inches. Mechanical joints and push on joints shall also conform in all respects to ANSI/AWWA C111/A21.11.

(2) Ductile iron compact fittings, meeting the requirements of ANSI/AWWA C153/A21.53, will also be accepted.

(3) Fittings shall be 350 psi pressure rating for sizes through 24 inches and shall be 250 psi rating for sizes above 24 inches unless a higher operating pressure is shown on the Drawings, and in such cases the fitting pressure rating shall be equal to or above the operating pressure. The pressure rating for all compact fittings shall be 350 psi.

(4) Fittings shall be ductile iron meeting the above requirements and shall be furnished complete with all joint accessories.

b. Lining and Coating

(1) All fittings shall be lined and coated the same as adjacent pipe.

3. Joints

a. General

(1) Pipe joints shall be mechanical joint, rubber ring slip joint or restrained joint as shown on the Drawings.

(2) All items used for jointing pipe shall be furnished with the pipe. The joints shall be made with tools and lubricant in strict conformity with the manufacturer's instructions. Copies of the instructions shall be delivered to the ENGINEER at start of construction in sufficient numbers that will permit the ENGINEER to retain 3 copies.

b. Mechanical Joints

(1) Mechanical joints are to be furnished according to ANSI/ AWWA C111/A21.11. All pipe joints must be furnished complete with all accessories. Mechanical joint bolts and nuts shall be of alloy cast iron or alloy steel (Corten type

such as U.S. Alloy) or equal. Rubber gaskets shall be made of plain first grade rubber, free of imperfections and porosity. Hardness shall be 75 X 5 durometer.

c. Rubber Ring Slip Joint (Push On)

(1) Rubber ring slip joint shall be equal to ANSI/AWWA C111/ A21.11. The joints shall be of the following materials and assembled in the sequence outlined below:

(a) Rubber ring gasket compressed in groove in bell of pipe.

(b) Beveled spigot end of pipe for initial centering into rubber gasket in bell.

d. Restrained Joints

(1) For Pipe

(a) Restrained joint for push-on type bell with rubber O-ring shall meet the applicable requirements of ANSI/AWWA C 111/A21.11. The bell/spigot configuration for the restrained joint shall be such that restraint shall be provided for the joint based on a sustained pressure equal to the pressure class of the pipe.

(b) The restrained joint shall allow the same deflection as standard push-on joint pipe.

(c) Where field welding is required for restrained field cut pipe, the welder shall be properly instructed in the methods and materials for welding on ductile iron pipe.

(2) For Fittings

(a) Where restrained joint fittings are called for, the bell configuration for the fittings shall be the same as for the pipe.

(b) Where fittings with restrained joint bell configuration are not available, restrained materials for use with mechanical joint bell configurations shall be used as follows:

(i) Connect mechanical joint bell assemblies with stainless steel all-thread rods.

(ii) Install restraints glands on each side of the fitting. The restraining glands shall be “Meg-a-Lug,” as manufactured by EBAA Iron Sales, Inc., of Eastland Texas; “Grip Ring,” as manufactured by Romac Industries, Inc., of Seattle, Washington; or equal.

e. Special Gaskets

(1) Where a water main is located within a 200-foot radius of an underground storage tank (UST), special rubber gaskets shall be provided for the water main joints.

(2) These gaskets shall be manufactured of “nitrile rubber” material or other acceptable material possessing superior resistance to deterioration from petroleum based products.

(3) This requirement will apply to the gaskets supplied for mechanical joints, restrained joints, and push-on joints when located within the 200-foot radius of a UST.

(4) The cost of the special gasket shall be incorporated into the cost of the installed pipe.

4. Lining and Coating

a. Water Service

(1) All ductile iron pipe for water service shall have manufacturer's standard outside bituminous or asphaltic base coating and a cement lining and bituminous seal coat on the inside. Cement mortar lining and bituminous seal coat inside shall conform to ANSI/AWWA C104/A21.4.

b. Sewer Force Main Service

(1) All ductile iron pipe for sewer force main service shall be bituminous coated outside and shall be cement lined with seal coat on the inside per the above specifications.

c. Bitumastic Finish Coat

(1) Only a coal tar outside coating, or other compatible coating, shall be applied to pipe which is to receive a bitumastic finish coat.

B. Ductile Iron Pipe-Flanged, Grooved and Special Coupling

1. Pipe

a. Flanged Pipe

(1) Flanged pipe shall be made in accordance with ANSI/AWWA C115/A21.15 Specifications, and shall be thickness Class 53.

(2) Where plain ends of flanged and plain end pipe fit into mechanical joint bells, centrifugally cast pipe shall be used.

b. Grooved Pipe

(1) Where flanged ductile iron pipe is shown on the Drawings, grooved joint piping may be substituted where acceptable to the ENGINEER.

(2) Grooved joint piping shall conform to ANSI/AWWA Specification C 606.

2. Fittings

a. Flanged Pipe

(1) Flanged joint fittings shall conform to ANSI/AWWA C110/ A21.10 Standard for Gray Iron and Ductile Iron Fittings- 3-inch through 48-inch.

(2) Fittings shall be 250 psi pressure rating for all sizes unless a higher operating pressure is shown on the Drawings and in such cases the fitting pressure rating shall be equal to or above the operating pressure.

(3) Fittings shall be ductile iron meeting the above requirements and shall be furnished complete with all joint accessories.

3. Joints

a. General

(1) Pipe joints shall be as shown on the Drawings.

(2) All items used for jointing pipe shall be furnished with the pipe. The joints shall be made with tools and lubricant in strict conformity with the manufacturer's instructions. Copies of the instructions shall be delivered to the

ENGINEER at start of construction in sufficient numbers that will permit the ENGINEER to retain 3 copies.

b. Flanged Pipe

(1) All ductile iron flanged pipe shall have flanges faced and drilled, 125 pound in accordance with ANSI/AWWA C110/ A21.10 unless otherwise specified.

(2) Flanges may be cast integrally with the pipe or they may be screwed on specially designed long hub flanges, refaced across both face of flange and end of pipe.

(3) Flanged joints are to be furnished according to ANSI/AWWA C115/A21.15 and shall be ductile iron only. Flanged joints shall have 1/8-inch rubber full face gaskets made especially for water pipe use. Bolts for ductile iron flanged pipe must be of standard sizes for pipe to be fitted, and must be black steel, machine bolts with heavy hexagon heads and nuts meeting ANSI B18.2.1 and ANSI B18.2.2, respectively. In unheated vaults, submerged and/or damp locations, bolts and nuts for ductile iron flanged pipe shall be stainless steel. Prior to stainless steel nuts being placed on stainless steel bolts, the bolt threads shall be coated with anti-seize.

(4) The American Toruseal Flange Gasket Manufactured by American Cast Iron Pipe Company is an acceptable alternate to the above described gasket.

c. Grooved Pipe

(1) Victaulic Style 31 couplings, or equal, with flush seal gaskets shall be used. Rigid cut grooves shall be used except where flexible couplings are shown on the Drawings. In such case, flexible cut grooves shall be substituted.

d. Special Coupling

(1) Flexible couplings for flanged pipe shall be a mechanical joint cast to a special flanged joint using a neoprene O-ring in place of the usual 1/16-inch rubber ring gasket. The mechanical bell and special flanged joint piece shall be of ductile iron (ANSI/AWWA C110/A21.10) with bolt circle, bolt size and spacing conforming to ANSI/AWWA C110/A21.10 specifications. Mechanical joint follower flange shall be of ductile iron ASTM A 536 or malleable iron ASTM A 47, Grade 35018 or 32510, with high strength/weight ratio design. Bolts shall be fine grained high tensile malleable

iron with malleable iron hexagon nut. Stainless steel bolts and nuts shall be used in vaults and wet wells. Where pressures may exceed 20 psi, anchor studs shall be included with spigots of pipes connected drilled to receive ends of studs.

(2) At locations in flanged pipe where adaptors are not shown on the Drawings, the CONTRACTOR may, at his own cost and for flexibility of installation, use a coupling adapter after acceptance by the ENGINEER. In no event shall unrestrained mechanical joints or dresser type couplings be substituted for flanged joints.

4. Lining and Coating

a. Flanged Pipe

(1) Flanged pipe for water and wastewater service shall be cement lined and bituminous coated the same as written herein for ductile iron pipe, mechanical and rubber slip joint type.

b. Grooved Pipe

(1) Lining and coating shall be as specified for flanged pipe.

C. Polyvinyl Chloride (PVC) Pipe (AWWA)

1. Pipe

a. Distribution Mains

(1) This Specification covers 4-inch through 12-inch PVC pressure pipe made from Class 12454-B material as defined in ASTM D1784 and conforming with the outside diameter dimensions of ductile iron pipe and with wall thicknesses of DR series 14, 18 or 25.

(2) The pipe shall be manufactured to meet the requirements of ANSI/AWWA Specification C900 and these Specifications. It shall be furnished in the size and pressure class as shown on the Drawings, and in 20-foot lengths.

(3) The pipe shall have an integral bell end and gasket seal which is in compliance with the requirements of ASTM D 3139 and F 477.

b. Transmission and Distribution Mains

(1) This Specification covers 14-inch through 48-inch PVC pressure pipe made from Class 12454-B material, as defined in ASTM D1784, and conforming with the outside diameter dimensions of ductile iron pipe. Wall thicknesses shall conform to DR Series 14, 18, 21, 25 or 26 as shown on the Drawings.

(2) The pipe shall be manufactured to meet the requirements of ANSI/AWWA Specification C905 and these specifications. It shall be furnished in 20-foot lengths in the size and pressure class as shown on the Drawings.

(3) The pipe shall have an integral bell end and gasket seal which is in compliance with the requirements of ASTM D3139 and F477.

c. The marking of each piece shall include:

(1) Nominal size and O.D. base.

(2) PVC.

(3) Dimension ratio number.

(4) AWWA pressure class.

(5) AWWA standard designation number.

(6) Manufacturer's name or trademark and production record code.

(7) Seal (mark) of the testing agency that verified the suitability of the pipe material for potable water service.

2. Fittings and Couplings

a. Fittings for use with PVC pipe shall be ductile iron, slip-on or mechanical joint type.

b. If couplings are required, they shall be of the elastomeric-gasket type and shall conform with ANSI/AWWA C900.

D. Polyvinyl Chloride (PVC) Pipe (ASTM)

1. Pipe

a. This Specification covers rigid polyvinyl chloride pipe and fittings, hereinafter called PVC pipe and PVC fittings, for sizes 3/4-inch through 12-inch.

b. PVC pipe shall be extruded from Class 12454-B polyvinyl chloride material with a hydrostatic design stress of 2000 psi for water at 73.4 degrees Fahrenheit, designated as PVC 1120, meeting ASTM Specifications D 1784 for material. Three-fourths inch through 1-1/2 inch water service piping shall be PVC Schedule 40 as specified in ASTM D 1785. Two inch through 12-inch pipe for water and sewage force main service shall be SDR 21 for 200 psi allowable working pressure at 73.4 degrees Fahrenheit and a safety factor of 2.0, as specified in ASTM D 2241.

c. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform as commercially practical in color.

d. The workmanship, pipe dimensions and tolerances, outside diameters, wall thickness, eccentricity, sustained pressures, burst pressures, flattening, extrusion quality, marking and all other requirements of ASTM D 2241 shall be conformed with in all respects.

e. Pipe shall be furnished in 20-foot lengths. The pipe shall be plain end with bell on one end. Male ends of pipe must be beveled on the outside.

f. Pipe shall have a ring painted around the male end in such a manner as to allow field checking of setting depth of pipe in the socket. This requirement is made to assist construction superintendents and inspectors in visual inspection of pipe installation.

g. Pipe must be delivered to job site by means which will adequately support it, and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical.

h. Pipe must not be exposed to the direct rays of the sun for an extended period of time. If pipe is not to be installed shortly after delivery to the job site, it must be stored in a shaded location.

2. Fittings

a. Ductile Iron

(1) Ductile iron mechanical joint or push-in type fittings with appropriate adapters may be used with exterior PVC pipe. All such fittings shall be approved by the pipe manufacturer, and complete data sent to the ENGINEER, including the manufacturer's approval, for review.

3. Joints

a. Exterior Buried Pipe - Slip Joint Type

(1) Exterior buried pipe shall be jointed with slip-type joints with rubber gaskets.

(2) Pipe with bell end shall have all parts of the bell, including the gasket groove, made from the same extruded piece, integral with the pipe, and shall be thickened to meet standard dimension ratios of wall thickness to outside diameter. The gasket groove shall be constructed such that gasket rollout will not occur. Rubber gasketing shall conform to ASTM D 3139.

b. Interior - Solvent Weld

(1) Interior pipe shall be jointed by solvent welds.

(2) Since PVC welding solvent is engineered and formulated to perform with a given joint design, all solvent must be purchased from the manufacturer of the pipe.

(3) The PVC welding solvent shall be compounded to conform with the socket fit and the weather conditions at the time of installation and be such as to assure minimum installation cost and a weld of maximum strength.

c. Couplings

(1) Couplings shall be of the same material as the pipe and may be of the molded, or extruded type. They shall have a beveled entrance to prevent the wiping off of the lubricant from the male end of the pipe.

(2) PVC couplings shall have a minimum rating of 200 psi for continuous operation at 73.4 degrees Fahrenheit.

(3) The couplings shall have a positive pipe stop that will automatically and accurately position the pipe ends within the couplings. The pipe stop shall also permit the thermal expansion or contraction of the pipe ends.

E. Polyethylene Pipe for Water Mains and Force Mains

1. Pipe

a. General

(1) Polyethylene pipe and fittings shall comply with the requirements of ASTM D 1248, D 1505, D 1693, D 1928, D 2657, D 3035, D 2837 and D 2321.

b. Resins

(1) Only virgin polyethylene resins classified as Type III, Category 5, Grade P34 per ASTM D 3035 with densities of 0.955 p/cc maximum and melt index of 0.15 g/10 minutes maximum shall be used in the process of making the pipe. The resin shall contain antioxidants and be stabilized with carbon black.

c. Design

(1) The pipe shall have a long-term strength rating of 1,600 psi or more and be resistant to environmental stress cracking per procedure C of ASTM D 1928 for not less than 200 hours. The maximum allowable deflection is 5 percent with the pipe installed in accordance with these Specifications, using backfill material at 130 pounds per cubic foot, H-20 live load plus 50 percent impact but no internal pressure. The live load and impact may be disregarded in the calculations for trench conditions with 8 feet or more cover. Operating pressures are shown on the Drawings. Hydrostatic loading shall be considered when the pipe is to be installed below a permanent water table or body of water.

d. Wall Thickness Calculations

(1) The pipe manufacturer shall furnish calculations to support the pipe wall thickness for these various conditions for the ENGINEER'S review/acceptance before the materials are sent to the job site.

e. Quality

(1) No cracks, holes, foreign material, blisters, or other deleterious faults are permitted in the polyethylene pipe. It shall be homogeneous throughout including the heat fused joint. Polyethylene pipe will not be installed containing gouges or cuts that penetrate more than 10 percent of the wall thickness.

f. Water Stops

(1) The pipe manufacturer shall furnish a waterstop assembly for use with the pipe where the pipe passes through a structure wall so as to provide a watertight seal. The assembly shall be attached to the pipe with noncorroding materials.

g. Marking

(1) Each length of polyethylene pipe shall contain the manufacturer's brand name, pipe size and other data to enable an accurate tracing of the raw material source. Polyethylene pipe will not be installed containing gouges or cuts that penetrate more than 10 percent of the wall thickness.

2. Joints

a. Fusion

(1) Polyethylene pipe shall be joined by the heat fusion welding process. Welding equipment may be either gas fired or electric as the CONTRACTOR may select. The welding equipment must be capable of attaining the temperature recommended by the manufacturer for the particular polyethylene extrusion used on the project.

(2) The fusion equipment shall have hydraulic controls and gauges for monitoring fusion pressures. Also, an engine powered facing unit to trim the irregularities of the pipe ends shall be provided. The heated and thermostatically controlled plate shall contain a temperature gauge for monitoring the heat temperature throughout the fusion process.

b. Flange Adapters

(1) Threaded or solvent weld joints and connections are not permitted. Flange adapters as manufactured by the pipe supplier shall be used, butt-fused to the pipe and connected to other pipe material using a rubber gasket for sealing.

2.02 MATERIALS-SERVICE LINE PIPE

A. Copper Pipe and Fittings

1. Inside, Rigid with Solder Joint Connections

a. Small piping inside structures shall consist of standard copper tubing for water; Type "L" for general plumbing purposes. All fittings shall be "solder joint connection" cast or wrought bronze for water service for inside diameter of pipe sizes given. All stops, valves, hose bibbs, and unions shall be made with same joints or threaded iron pipe standard, and be of brass or copper. Use 95-5 tin-antimony solder for "solder joints."

b. Buried Copper Tubing with Compression Joints

(1) Small copper piping for buried service shall be of standard soft copper tubing for water service pipe, ASTM Specifications B 88, Type "K," with bronze fittings, stops, and valves having compression connections for flared copper tubing.

B. Polyethylene Pipe for Water Service

1. Pipe

a. Polyethylene flexible pipe (I.P.O.D. or PVC O.D.) for sizes 1/2-inch through 3-inch water service piping shall be PE 3408, Type III, Grade P34 Class C, DR-9, OD Based for 200 psi working pressure at 73.4 degrees Fahrenheit, meeting ASTM Specification D 1248 for material, D 3350 for cell classification and AWWA C901 Specification for pipe.

b. Polyethylene flexible pipe (copper pipe O.D.) for sizes 1/2-inch through 2-inch water service piping shall be PE 3408, Type III, Grade P34 Class C, DR, OD Based for 200 psi working pressure at 73.4 degrees Fahrenheit, meeting ASTM Specification D 1248 for material, D 3350 for cell classification and AWWA C901 Specification for pipe.

c. Pipe shall meet all applicable provisions of the Commercial Standards and shall bear the National Sanitation Foundation (NSF) seal of approval.

2. Fittings

a. Fittings shall be standard bronze fittings as specified for copper tubing in this Section of these Specifications.

2.03 SERVICE CONNECTIONS

A. General

1. All service connections shall be made by means of tees, factory tapped couplings, or bronze service clamps manufactured specifically for use with the pipe upon which it is to be installed. Whenever possible, corporation stops shall be placed in the service connection prior to conducting hydrostatic tests on the mains.

B. Service Clamps

1. Service clamps for use on ductile iron mains shall be bronze, double strap, Mueller BR 2 B Series, Ford, or equal.

2. Service clamps for use on PVC and polyethylene pipe shall be bronze, wide strap, 2 piece for 2-inch through 8-inch mains, Mueller H-01300 Series, Ford, or equal. For 10-inch and 12-inch mains, use Mueller 3-piece, H-13000 Series, Ford, or equal.

3. The use of Dresser Style 294 plastic saddles will also be permitted for use on PVC or polyethylene mains.

2.04 WALL AND FLOOR SLEEVES WITH RUBBER MECHANICAL SEAL FOR CARRIER PIPE SIZES 2 INCHES THROUGH 48 INCHES

A. General

1. Sleeves shall be required for 2-inch through 48-inch carrier pipes penetrating poured concrete walls and floor slabs. The use of sleeves will require the use of a rubber link, mechanical type seal assembly around the carrier pipe.

2. The CONTRACTOR shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall or floor sleeve shall be sized as recommended by the closure assembly manufacturer to fit the carrier pipe, and seal to assure a watertight joint. The CONTRACTOR shall follow the manufacturer's instructions for installing and tightening the seal to provide a watertight pipe penetration.

B. Description

1. The pipe closure assembly shall consist of a heavy wall welded or seamless steel pipe with 4 inches larger than sleeve O.D. continuous water stop plate, modular mechanical type interlocking synthetic rubber links shaped to continuously fill the annular space between the carrier pipe and wall or floor opening sleeve. Links shall be loosely assembled with stainless steel bolts to form a continuous sealing element of EPDM rubber belt around the carrier pipe with glass reinforced nylon plastic pressure plate under each bolt head and nut. Tightening of the bolts shall cause the sealing element to expand and provide absolute watertight seal between the carrier pipe and wall or floor sleeve. The entire closure assembly shall be tagged for location to match the nomenclature on the Drawings.

2. The sleeve shall be factory primed per Paint Specifications, Section 09900.

C. Manufacturers

1. Thunderline Corporation, Link-Seal Century Line Model CS-100, Model LS, FS, and WS. All models used shall be for Type S corrosive service, or equal.

2.05 SOURCE QUALITY CONTROL

A. Ductile Iron Pipe (Mechanical Joint and Rubber Slip Joint Type)

1. Hydrostatic and physical properties acceptance tests shall be in accordance with ANSI/AWWA Specification C151/A21.51 for ductile iron pipe centrifugally cast in metal molds or sand lined molds for water or other liquids.

2. The ENGINEER shall be provided with sufficient copies of each of the tests for each Contract to permit the ENGINEER to retain 3 copies.

3. All items used for jointing pipe shall be tested before shipment.

B. Polyvinyl Chloride (PVC) Pipe (AWWA)

1. The manufacturer shall furnish an affidavit that all delivered materials comply with the requirements of this Specification.

2. Each length of pipe shall be proof tested at four times its rated class pressure.

C. Polyvinyl Chloride (PVC) Pipe (ASTM)

1. Samples of pipe and physical and chemical data sheets shall be submitted to the ENGINEER for review and acceptance before pipe is delivered to job.

2. Samples of solvents and the recommended instruction for their use must be submitted for the ENGINEER'S review and acceptance before delivery of solvent to the job.

D. Polyethylene Pipe for Water Mains and Force Mains

1. Results of tests on the raw materials and the polyethylene pipe in accordance with ASTM standards and the Plastic Pipe Institute shall be furnished along with catalogs and other descriptive literature in the number of copies required by the listing in Section 00700 before the materials are sent to the job site.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION–WATER AND SEWAGE FORCE MAINS

A. General

1. Trenching shall include all clearing and grubbing, including all weeds, briars, trees and stumps encountered in the trenching, regardless of size. The CONTRACTOR shall dispose of any such material by burning, burial or hauling away or as noted on the Drawings, at no extra cost to the OWNER. Ornamental shrubs, hedges, and small trees (3 inches in diameter or less) shall be removed, protected, and replanted, at no extra cost to the OWNER.

2. Trenching also includes such items as railroad, street, road, sidewalk, pipe, and small creek crossings; cutting, moving, or repairing damage to fences, poles or gates and other surface structures, regardless of whether shown on the Drawings. The CONTRACTOR shall protect existing facilities against danger or damage while pipeline is being constructed and backfilled or from damage due to settlement of the backfill.

3. Materials encountered in excavation will be divided into 2 classes only: solid rock excavation and other materials. Solid rock excavation is defined as material requiring the use of specialty equipment for removal, such as “hoe ramming,” or the use of explosive materials for breakage prior to removal. Other materials shall include earth, loose rock, street or road surfacing and base concrete, and boulders less than 1/3 cubic yard in one piece.

4. In case of “unclassified excavation,” as designated in the Drawings and/or Specifications, the price bid shall include earth, solid rock, roots, street or road surfacing and base concrete and boulders.

5. In case of “classified excavation,” as designated in the Drawings and/or Specifications, the CONTRACTOR will be paid an additional cost for the removal of solid rock over that bid for other materials.

6. All excavation shall be open trench, except where the Drawings call for tunneling, boring, or jacking under structures, railroads, sidewalks, roads, or highways.

B. Trees and Shrubs

1. Where pipelines run through wooded terrain, cutting of trees within limits of maximum permissible trench widths, as set forth in this article, will be permitted. However, cutting of additional trees on sides of trench to accommodate operating of trenching machine will not be permitted. The CONTRACTOR shall obtain specific permission of the OWNER before cutting any tree larger than 4 inches in diameter.

C. Highways, Streets and Railroads

1. Construction equipment injurious to paving encountered shall not be used. Curbs, sidewalks, and other structures shall be protected by the CONTRACTOR from damage by his construction equipment.

2. Where trenching is cut through paving which does not crumble on edges, trench edge shall be cut to at least 2 inches deep to straight and neat edges, before excavation is started, and care taken to preserve the edge to facilitate neat repaving.

3. The CONTRACTOR shall so coordinate his work as to produce a minimum of interference with normal traffic on highways and streets. He may, with the approval of the governing agency, close a street to traffic for such length of time considered necessary, provided persons occupying property abutting the street have an alternate route of access to the property which is suitable for their needs during the time of closure. It shall be the responsibility of the CONTRACTOR to give 24 hours advance notice to fire and police departments and to occupants of a street which will be closed, in a manner approved by the governing body.

4. The CONTRACTOR shall maintain road crossings in a passable condition for traffic until the final acceptance of the work, being paid only by unit price for crushed rock used, within limitations as hereinafter specified.

5. The amount of crushed stone placed shall be paid for at the unit price per ton up to the maximum limits of 225 pounds per linear foot of trench over which it is placed for pipe sizes through 16 inches, 300 pounds per

linear foot for pipe sizes 18 inches through 24 inches and 400 pounds per linear foot for sizes 27 inches through 48 inches. The ENGINEER shall have control of thickness and width to be placed and paid for, and may order changes in depth and width as conditions dictate. No payment will be made for crushed rock surfacing required as a result of unnecessarily wide trenches, omission of sheeting and shoring, or damage by the CONTRACTOR'S equipment, or for maintenance of surface level.

6. Railroad and Highway Department requirements in regard to trenching, tunneling, boring and jacking shall take precedence over the foregoing general specifications and the tunneling and boring or jacking specifications, where they are involved. Where work is within railroad right-of-way, Railroad Protective Insurance shall be carried by the CONTRACTOR in the amounts required by the Railroad Company.

7. The insurance policy shall name the railroad as the insured and the original policy shall be delivered to the railroad after submitting same to the OWNER for review. The cost of flagmen required by the railroad and highway departments and railroad inspectors shall be paid by the CONTRACTOR.

8. Uneven surfaces or humps in the ground encountered and high driveways and road crossings shall be dug through to such depth that pipe may be laid to a reasonably even grade and have minimum cover at the low places. Such places requiring extra depths shall be included in the bid and no extra payment will be made for such extra depths required, which are evident from an examination of the ground before bidding, as required for 1 foot cover over valve nuts, or are indicated on the Drawings.

D. Existing Utilities

1. The CONTRACTOR shall determine, as far as possible in advance, the location of all existing sewer, culvert, drain, water, electric, telephone conduits, and gas pipes, and other subsurface structures and avoid disturbing same in opening his trenches. In case of sewer, water and gas services and other facilities easily damaged by machine trenching, same shall be uncovered without damage ahead of trenching machine and left intact or removed without permanent damage ahead of trenching and restored immediately after trenching machine has passed, without extra cost to the OWNER. The CONTRACTOR shall protect such existing facilities, including power and telephone poles and guy wires, against danger or damage while pipeline is being constructed and backfilled, or from damage due to settlement of his backfill. It shall be the responsibility of the CONTRACTOR to inform the customers of utilities of disruption of any utility service as soon as it is known that it has been or will be cut off.

2. The CONTRACTOR shall, at all times during trenching operations, carry a stock of pipe and fittings likely to be needed for replacement of pipelines to facilitate immediate repair.

E. Pipelines in Same Trench

1. Pipelines, force mains, and sewers laid in same trench shall, in all cases, be bedded on original earth, or other specified bedding materials, regardless of divergence in their elevations, unless otherwise specified. They shall never be laid in unsupporting backfill or one above the other. The CONTRACTOR shall receive full trenching and backfilling unit prices for each pipeline, force main, and sewer so laid, the same as if laid in widely separated trenches.

F. Location of Proposed Pipelines

1. The location of pipelines and their appurtenances as shown are those intended for the final construction. However, conditions may present themselves before construction on any line is started that would indicate desirable changes in location. Also, development of property traversed may require location changes. In such cases, the OWNER reserves the right to make reasonable changes in line and structure locations without extra cost, except as may be determined by the application of the unit prices bid to the quantities actually involved. The OWNER is under no obligation to locate pipelines so that they may be excavated by machine.

G. Trench Requirements

1. All trenches must be dug neatly to lines and grades.

2. The opening of more than 500 feet of trench ahead of pipe laying and more than 500 feet of open ditch left behind pipe laying, before backfilling, will not be permitted, except upon written consent of the OWNER. No trench shall be left open or work stopped on same for a considerable length of time. In case of objectionable delay trench shall be refilled according to backfill specifications.

3. Where subgrade of trench has insufficient stability to support the pipeline and hold it to its original grade, the ENGINEER may order stabilization by various means. Exclusive of dewatering normally required for construction and instability caused by neglect of the CONTRACTOR, it shall be paid for at unit prices set up in the Contract, such as extra excavation, crushed rock for pipe bedding, concrete cradle or piling.

4. Excavation for pipe laying must be made of sufficient width to allow for proper jointing and alignment of the pipe, but not greater than the maximums permitted in the following table:

MAXIMUM TRENCH WIDTH AT TOP OF PIPE

Nominal Pipe Size (Ins.)	Trench Width (Ins.)	Nominal Pipe Size (Ins.)	Trench Width (Ins.)
4	28	20	44
6	30	24	48
8	32	30	54
10	34	36	60
12	36	42	66
14	38	48	72
16	40	54	78
18	42		

5. Trenches in earth or rock shall be dug as shown on the Drawings and be sufficiently deep to insure a 30 inch or 36 inch minimum cover over water lines and force mains, as noted on the Drawings. Depths of trenching shall also be adequate for at least 1 foot minimum cover over valve nuts. In order to eliminate the necessity for digging bell holes into the trench subgrade by hand and to insure an earth cushion under the pipe for uniform bearing, trench depth shall be the cover requirement plus outside diameter of barrel of pipe plus the required bedding cushion. The cushion construction requirement shall also apply to tunnels.

6. Wherever it is deemed necessary by the ENGINEER to lay the pipes to an extra depth exceeding the depths required by the Drawings and Specifications and not apparent from unevenness of ground, the CONTRACTOR will be paid for such excavation under extra excavation in earth at the price bid per cubic yard, computed on the basis of maximum trench widths in the preceding table. In unclassified excavation contracts the same width limitations will apply.

7. Trench line stations and locations of accessories will be set ahead of the trenching. These will be set at least each 100 feet of pipeline. Trenches must be dug true to alignment of stakes. Alignment of trenches or pipes in trench must not be changed to pass around obstacles such as poles, fences and other evident obstructions without the permission of the ENGINEER. Lines will be laid out to avoid obstacles as far as possible, contingent with maintenance of alignment necessary to finding pipeline in the future and avoiding obstruction to future utilities.

H. Damage to Existing Structures

1. Hand trenching is required, at no extra payment, where undue damage would be caused to existing structures and facilities by machine trenching.

2. In case of damage to any existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structure will be in as good condition and serve its purpose as completely as before, and such restoration and repair shall be done without extra charge, except as set forth under the applicable provisions of the General and Special Conditions. Where there is the possibility of damage to existing utility lines by trenching machine, the CONTRACTOR shall make hand search excavation ahead of machine trenching, to uncover same, at no extra cost to the OWNER.

I. Excavation Unclassified

1. Excavation for pipelines shall be unclassified and the cost of all excavation of whatever nature and state, including solid rock, shall be included in the CONTRACTOR'S unit price bid for furnishing, trenching, laying and backfilling the pipe.

2. Excavation for structures such as manholes, pump stations, and vaults is likewise unclassified and the cost of all excavation of whatever nature and state, including solid rock, shall be included in the CONTRACTOR'S lump sum or unit price bid, as the case may be.

J. Dewatering of Trenches

1. Dewatering of trenches shall be considered a part of trenching, at no extra cost to the OWNER. Dewatering of trenches shall include groundwater and storm or sanitary sewage. Suitable pumping and other dewatering equipment is to be provided by the CONTRACTOR, to insure the installation of the pipeline structure in a dewatered trench and under the proper conditions. Dewatering shall include all practical means available for prevention of surface runoff into trenches and scouring against newly laid pipe.

2. Piles of excavated materials shall be trenched or temporarily piped to prevent, as far as practical, blockage of drainage ditches and gutters, and water carriage of excavated materials over street and highway surfaces.

3.02 LAYING WATER AND SEWAGE FORCE MAINS

A. General

1. Inspection of Materials

a. All pipe, fittings and accessories shall be subject to an inspection by the OWNER at the job site. Any damaged materials shall be repaired or replaced to the satisfaction of the OWNER. Should repairs to the piping materials be necessary, then same shall be

made in the presence of the ENGINEER using proven methods prescribed by the pipe manufacturer.

b. The OWNER'S inspection of materials shall in no way relieve the CONTRACTOR of his responsibility.

2. Laying Requirements

a. Water and sewage force main pipe shall be laid to lines, cover or grades shown on the Drawings.

b. Pipes must be swabbed out before lowering into trench. In the case of pipelines 4 inch through 20 inch, a swab must also be dragged through the pipe after it is in place. Larger size pipe shall be visually inspected for cleanliness and proper jointing.

c. The points insisted upon in the laying of pipe will be: Proper alignment, evenness of width and depth of joints, perfection in jointing, and care of the pipe in handling.

d. Precautions must be taken to prevent flotation of the pipe should water enter the trench prior to putting the pipeline into operation.

e. In wet, yielding and mucky locations where pipe is in danger of sinking below grade or floating out of grade or alignment, or where the backfill materials are of such a fluid nature that such movements of the pipe might take place during the placing of the backfill, the pipe must be weighted or secured permanently in place by such means as will prove effective. If crushed rock fill beneath the pipe is necessary for stability, it will be paid for at the unit price bid per ton of such material in place except in cases where instability is caused by neglect of the CONTRACTOR.

f. Whenever pipe laying is stopped, the end of the pipe shall be securely plugged with the manufacturer's standard plug held in place by bracing and/or blocking.

g. Elbows, plugs, dead end valves, and tees shall be firmly blocked, as shown on the Drawings, to prevent internal pressure from springing the pipe from the intended alignment, with permanent materials solidly placed without covering pipe joints. Restrained type pipe joints may be substituted for thrust blocks with the ENGINEER'S permission. Pipe shall be free of all structures, other than manholes, vaults, or planned entries into other structures.

h. No pipe shall be laid resting on solid rock, blocking or other unyielding objects. Jointing before placing in the trench and subsequent lowering of more than one section jointed together may be allowed, subject to the ENGINEER'S permission.

i. For PVC and polyethylene pipe, there shall be installed with the pipe #12 AWG insulated wire for the entire length of the pipeline. The wire shall be installed on top of the 12-inch initial backfill and weighted at locations along the wire sufficient to prevent dislodgement during the backfilling process. The wire shall be accessible at valve boxes or at locater stations along the route of the pipeline, as shown on the Drawings.

j. Concrete line markers shall be installed at property lines or at bends in the pipeline. Markers may be long markers or short markers as shown on the Drawings or as called for in these Specifications.

k. Fiberglass line markers shall be installed at valve locations or at locations as shown on the Drawings. Fiberglass markers shall be Carsonite Utility Marker, Style No. 375, or approved equal. Markers shall be equipped with the OWNER'S standard logo.

3. Installing Water Pipe in Cover Pipe

a. Installation of water pipe in cover pipe is covered in Section 31 7119 of these specifications.

B. Laying Ductile Iron Pipe

1. Bedding and Backfilling

a. The laying condition shall be Type 3 specified in ANSI/AWWA C600. The pipe shall be bedded in 4 inches minimum loose soil and the hand placed loose soil backfill lightly consolidated to the top of the pipe. "Loose soil" or "select material" is defined as native soil excavated from the trench, free of rocks, foreign materials, and frozen earth.

b. The selected material shall be hand placed to a point 12 inches above the barrel of the pipe. After the specified backfill is hand placed, rock may be used in machine placed backfill in pieces no larger than 8 inches in any dimension and to an extent not greater than 1/2 the volume of the backfill materials used.

c. The top 12 inches of backfill shall contain no rock over 1-1/2 inches in diameter nor pockets of crushed rock.

d. Larger rock fill will be allowed in wide trenches where side slopes are low enough to prevent rock from dropping over pipeline. If additional earth is required, it must be obtained and placed by the CONTRACTOR. Filling with rock and earth shall proceed simultaneously, in order that all voids be filled with earth.

e. If select material is not available from the trench excavation, or if the CONTRACTOR so desires, he may use crushed stone bedding and backfill to the top of the pipe at no extra cost to the OWNER.

f. Sufficient space, limited to a maximum of 2 feet length, shall be left out of the specified earth or crushed stone bedding to facilitate proper jointing of the pipe.

2. Installation of Pipe

a. Ductile iron pipe shall first be thoroughly cleaned at joints, then joined according to instructions and with tools recommended by the pipe manufacturer. Sufficient copies of the manufacturer's installation instructions shall be furnished the ENGINEER to permit the ENGINEER to retain 3 copies. One copy shall be available at all times at the site of the work.

b. All pipes must be forced and held together or "homed" at the joints before bolting. Pipe must be aligned as each joint is placed, so as to present as nearly true, straight lines and grades as practical, and all curves and changes in grades must be laid in such manner that 1/2 of the maximum allowable deflection shown in the pipe manufacturer's catalog is not exceeded.

c. Concrete blocking of fittings shall be as specified hereinafter in this Specification Section 02610.

d. Cutting of pipe may be done by special pipe cutters as the CONTRACTOR may elect, but the CONTRACTOR will be held responsible for breakage or damage caused by careless cutting or handling. Cut edges of the pipe shall be made smooth and a bevel formed on the exterior of the pipe barrel when using rubber gasket type pipe.

C. Laying Copper Pipe and Fittings

1. Bedding and Backfilling

a. The pipe shall be bedded in 4 inches minimum of loose soil and the hand placed backfill lightly consolidated to a depth of 12 inches above the top of the pipe. "Loose soil" or "select material" is defined as native soil excavated from the trench, free of rocks, foreign materials and frozen earth. The machine placed backfill may contain rock no larger than 8 inches in any dimension and to an extent no greater than half the volume of backfill materials used. The top 12 inches of backfill shall contain no rocks over 1-1/2 inches in diameter nor pockets of crushed rock.

2. Installing Copper Pipe and Fittings

a. Exterior copper pipe shall be laid of type K pipe, with brass compression fittings. Joints shall be neatly reamed and flared and joints drawn up firmly. Pipe shall have at least 30 inch cover. Joints shall be tested and all leakage stopped before backfilling the pipe trench.

b. Interior copper pipe shall be installed of Type L pipe, with sweat joint fittings. Pipe shall be tested and all leaks stopped before the system will be accepted. The pipe shall be free of dents and bends. The sweat joints shall present a neat appearance. All pipe shall be parallel to walls and floors with unions on all runs and branches. The pipe shall be secured to the walls and ceilings by clamps and hangers manufactured for the purpose. Strap hangers are not acceptable. Unions and valves shall be placed on each outlet to facilitate dismantling and shutting off.

c. All copper pipe shall be installed by experienced workmen.

D. Installation of Flanged or Threaded Pipe and Fittings (Interior)

1. Installation - General

a. The CONTRACTOR shall thoroughly clean the pipe and fittings before starting erection. All scale, rust and dirt shall be removed by power brushing and/or solvent cleaning.

b. The erection of piping requires that it progress from the equipment it is connected to, after the equipment has been accurately leveled and aligned, without putting a strain on same. The pipe shall be erected in a workmanlike manner with runs in the true horizontal or vertical plane or as shown on the Drawings.

c. The piping shall be supported by standard pipe hangers or piers rather than by the equipment. The pipe shall be free of all openings in walls and slabs when the final position of the piping is attained and before sealing the annular space about the pipe.

2. Flanged Joint Connection

a. All flanged type connections shall be made using an acceptable gasket and bolts. The bolts shall be tightened evenly to compress the gasket. Care is to be taken not to distort the flanges and/or piping by overtightening the bolts. Final tightening of bolts shall be done with a properly adjusted torque wrench.

3. Threaded Joint Connection

a. All threads shall be full, complete, and made with sharp dies. The ends of the pipe shall be reamed to remove all burrs and all threads must be free of rust and other foreign matter at the time the joint compound is applied. Joint thread compounds must be acceptable to the ENGINEER before use.

b. Pipe threads shall be tapered and in accordance with API Standard 5B. Not more than 3 threads at each joint may be exposed after the connection is made.

c. Unions shall be included to allow for proper assembly and disassembly of each run of pipe. Provide a union on each run of pipe connecting to threaded valves, devices, and equipment.

4. Interface with Other Products

a. When a pipe transitions from ductile iron to pipe of another material, a transition fitting shall be used. The transition material shall be a dielectric material or insulator. For pressure applications above 20 psi the transition fitting shall be a Straub pipe joint, a Dresser type coupling, or equal. For low pressure or gravity applications, the transition fitting shall be a Straub pipe joint, a Dresser type coupling, a Fernco fitting, or equal. All transition couplings shall be approved by the ENGINEER prior to installation.

E. Laying Plastic Pipe

1. Bedding and Backfill - General

a. The pipe shall be bedded in 4 inches minimum depth (for pipe sizes through 16 inches) of crushed rock meeting the requirements of Class I material as specified in ASTM D 2321, except the gradation shall be Kentucky Department of Highways standard size No. 9. For pipe sizes greater than 16 inches in diameter, the pipe bedding shall be a minimum depth of one-fourth the pipe diameter and be of the material and gradation specified previously.

b. Similar material shall be used for haunching up to the spring line of the pipe and it shall be worked under the haunch of the pipe to provide adequate side support. The crushed rock meeting the requirements of Class I (ASTM D 2321) shall then be hand placed to a point 12 inches above the top of the pipe. The remaining backfill, except for the top 12 inches which shall contain no rock over 1-1/2 inch diameter nor pockets of crushed rock, may be excavated material containing no rock over 8 inches in any

dimension. Larger rock will be allowed in wide trenches where side slopes are low enough to prevent rock from dropping over pipeline. If additional earth is required, it must be obtained and placed by the CONTRACTOR. Filling with rock and earth shall proceed simultaneously, in order that all voids may be filled with earth.

c. Sufficient space, limited to a maximum of 2 feet length, shall be left out of the bedding to facilitate proper jointing of the pipe.

d. No pipe shall be laid resting on solid rock, blocking, or other unyielding objects. Jointing before placing in the trench and subsequent lowering of more than one section may be allowed subject to the ENGINEER'S permission.

2. Installation of Polyvinyl Chloride (PVC) Pressure Pipe

a. Prior to laying, all PVC pipe shall be stored in a shaded place for protection from the direct rays of the sun. Pipe shall be distributed from storage as the work progresses as permitted by the ENGINEER.

b. The pipe, fittings, and valves shall be placed in the trench with care. Under no circumstances shall pipe or other materials be dropped or dumped into the trench. The pipe shall not be dragged in a manner which would cause scratching of the pipe surface. An excessive amount of scratching on the surface of the pipe will be considered cause for rejection.

c. Sufficient copies of the pipe manufacturer's instructions for installing the pipe and accessories shall be furnished the ENGINEER by the CONTRACTOR to permit the ENGINEER to retain 3 copies. A copy is to be available at the job site at all times.

d. Concrete blocking of fittings, as hereinafter specified, shall be required for PVC pipe with slip joints and rubber gaskets.

e. All dirt, dust and moisture shall be removed from the bell and spigot ends of pipes to be jointed. Insert gasket in bell. Apply the lubricant to spigot and gasket being careful to keep both ends free of dirt. The joint shall be homed to stop mark on spigot end of pipe. All jointing shall be done in accordance with pipe manufacturer's recommendations.

f. All cutting of the pipe shall be done in a neat and workmanlike manner with the least amount of waste of pipe involved and without damage to existing or new lines. A fine tooth saw, tubing cutter or similar tool can be used to cut the pipe. Cut must be

square and ragged edges removed with a cutting tool and/or file. A bevel or taper on the exterior of each spigot is required.

3. Installation of Polyethylene Pressure Pipe

   a. Polyethylene pipe for water lines or force mains shall be joined using tools and equipment specifically manufactured for use with polyethylene pipe. Heat fusion temperature, heating time and cooling time shall be per the pipe manufacturer's requirements. Pouring of water on completed joints to speed cooling will not be allowed.

   b. The pipe shall be snaked into the trench, employing the natural snaking tendency of the pipe. All short radius bends shall be made with fittings rather than bending the pipe. The pipe will be rejected if it contains kinks and gouges or gouges/cuts penetrating to a depth of 10 percent of the wall thickness.

   c. Sufficient copies of the pipe manufacturer's instructions for installing the pipe and accessories shall be furnished the ENGINEER by the CONTRACTOR to permit the ENGINEER to retain 3 copies. A copy is to be available at the job site at all time.

   d. Because of the high coefficient of expansion of polyethylene, the pipe shall not be attached to rigid structures at the ends until at least 48 hours have elapsed after backfilling and the pipe temperature has had an opportunity to stabilize.

4. Installing Polyethylene Pipe for Water Service

   a. The pipe shall be bedded in 4 inches minimum of loose soil and the hand placed backfill lightly consolidated to a depth of 12 inches above the top of the pipe. "Loose soil" or "select material" is defined as native soil excavated from the trench, free of rocks, foreign materials and frozen earth. The machine placed backfill may contain rock no larger than 8 inches in any dimension and to an extent no greater than half the volume of backfill materials used. The top 12 inches of backfill shall contain no rocks over 1-1/2 inches in diameter nor pockets of crushed rock.

   b. Polyethylene pipe for water services shall have the same outside diameter as copper tubing and shall be compatible for flared compression fittings. The joints to brass fittings shall be made by cutting the pipe with a tube cutter, keeping it clean and square, thence flaring the pipe and completing the joining in accordance with the manufacturer's instructions (a copy of the instructions shall be at the job site at all times). All joints shall be tested and all leakage stopped before backfilling the pipe trench.

c. The pipe shall be snaked into the trench, employing the natural snaking tendency of the pipe. All short radius bends shall be made with fittings rather than with the pipe alone. The pipe shall be bent to a radius of not less than 12 inches.

d. The pipe will be rejected if it contains kinks and gouges.

F. Installation of Water Service Accessories

1. Water Service Meters

a. Water service meters and accessories shall be installed as shown on the Drawings, with meter box centered over the meter.

b. The location of water service connections will be determined in the field, as the work progresses, thereby necessitating the use of pipe saddles and the appropriate tapping equipment. Earth backfill shall be thoroughly tamped around meter boxes to prevent subsequent movement.

2. Air Valves and Corporation Stops

a. The location of air valve assemblies, while being noted on the Drawings, could possibly be shifted in actual construction. For this reason, the same statements relative to the methods of installation of meters and water service connections apply to the installation of air valve assemblies. Air valve assembly boxes shall be installed in the same manner as water meter boxes except that the box will be located slightly off center of the air valve, in order to give better access to the stopcock between the valve and water main.

b. Corporation stops, as shown on the Drawings, are required between the water main and the meter, and between the main and the air valve assembly.

G. Installation of Fire Hydrants

1. Fire hydrants shall be installed in the general location as shown on the Drawings. Exact location shall be determined in the field. Hydrants shall be set such that the lowest nozzle shall be high enough above the ground to allow the uninhibited 360 degree swing of a 15-inch hydrant wrench.

2. Hydrant drainage pits shall be excavated below the hydrant to the depth shown on the Drawings. Crushed stone drainage media shall be of the size shown on the Drawings. Hydrant shall be set vertical and anchored as hereinafter specified.

3. Hydrants installed on this project shall be anchored to prevent the hydrant from blowing off the feeder line when suddenly opened or closed. Likewise, the hydrant pilot valve shall be anchored to prevent blowoff when the hydrant is removed. The CONTRACTOR shall anchor the hydrant and pilot valve utilizing one of the following procedures:

    a. Where the hydrant is located immediately adjacent to the water main, install all thread rods from the main line branch tee to the valve inlet and from the valve outlet to the mechanical joint of the hydrant inlet piece.

    b. Provide locked mechanical joint and/or restrained joint piping from the main to the hydrant including the main line tee.

    c. Use method a or b from the water main to the pilot valve and provide a concrete thrust block on the hydrant.

    d. Method b may not be used when the hydrant feed line is PVC pipe.

4. The additional cost of providing all-thread rods, locked mechanical joint pipe and fittings, restrained joint pipe and fittings, and/or the concrete thrust block at the hydrant shall be included in the CONTRACTOR'S unit price bid for the hydrant.

H. Blocking of Pipe at Bends and Ends

1. Horizontal Bends

    a. Concrete backing and/or blocking required at bends in the horizontal plane shall be accomplished per detail on the Drawings. The square footage of blocking area shall be obtained from Tables "A" and "B" through the following procedure:

        Step No. 1 - From Table "A," select type soil and bearing area factor for particular fitting to be blocked.

        Step No. 2 - From Table "B," select multiplier to be used for the size pipe being blocked and its test pressure.

        Step No. 3 - Calculate actual bearing area required by multiplying bearing area factor from Table "A" by multiplier from Table "B" (e.g. - 16 inch tee with 250 psi test pressure in sandy clay - 9.42 x 1.78 = 16.7 S.F. of bearing area required). Bearing area shall in no case be less than the minimum shown in Table "B."

TABLE "A"

Type Soil	Soil Bearing Pressure (PSF)	Bearing Area Factor for Degree of Bend (Square Feet) 90˚ Plug/Tee	45˚	22 1/2˚	11 1/4˚
Sandy Clay	3,000	13.33	9.42	7.21	3.68	1.85
Hard Clay	6,000	6.66	4.71	3.61	1.84	0.92
Shale	12,000	3.33	2.36	1.80	0.92	0.46
Solid Rock	16,000	2.50	1.77	1.35	0.69	0.35

TABLE "B"

Pipe Dia. (In.)	Min. Bearing Area (S.F.)	Multiplier for Pipe Test Pressure (TP) (TP) 350 psi	(TP) 300 psi	(TP) 250 psi	(TP) 200 psi	(TP) 150 psi	(TP) 100 psi	(TP) 50 psi
4	1.0	0.16	0.13	0.11	0.09	0.07	0.04	0.02
6	1.0	0.35	0.30	0.25	0.20	0.15	0.10	0.05
8	1.0	0.62	0.53	0.44	0.36	0.27	0.18	0.09
10	1.0	0.97	0.83	0.69	0.56	0.42	0.28	0.14
12	1.3	1.40	1.20	1.00	0.80	0.60	0.40	0.20
14	1.5	1.91	1.63	1.36	1.09	0.82	0.54	0.27
16	1.8	2.49	2.13	1.78	1.42	1.07	0.71	0.36
18	2.3	3.15	2.70	2.25	1.80	1.35	0.90	0.45
20	2.5	3.89	3.33	2.78	2.22	1.67	1.11	0.56
24	3.6	5.60	4.80	4.00	3.20	2.40	1.60	0.80
30	5.2	8.75	7.50	6.25	5.00	3.75	2.50	1.25
36	7.0	12.60	10.80	9.00	7.20	5.40	3.60	1.80
42	9.1	17.15	14.70	12.25	9.80	7.35	4.90	2.45
48	11.4	22.40	19.20	16.00	12.80	9.60	6.40	3.20
54	13.5	28.35	24.30	20.25	16.20	12.15	8.10	4.05
60	16.0	35.00	30.00	25.00	20.00	15.00	10.00	5.00

b. Consideration will be given to the use of restrained type mechanical joint pipe and fittings in lieu of concrete blocking. Use of the restrained joint pipe and fittings is subject to review and acceptance by the ENGINEER of the locking-method and adequacy of design for pressures involved.

2. Vertical Bends

a. The use of vertical bends in lieu of extra depth trenching shall be subject to permission by the ENGINEER.

b. Where the CONTRACTOR elects to use vertical bends, or where vertical bends are called for on the Drawings, the CONTRACTOR shall submit the blocking design, including calculations, to the ENGINEER for review and acceptance. Anchorages shall be designed to resist thrusts caused by the internal test pressure in the pipe. Protection against corrosion shall be inherent in the design.

I. Supplemental Backfilling Information

1. General

a. Excavated materials from trenches, tunnels, and structure excavation in excess of quantity required for trench backfill or site regrade, shall be disposed of by the CONTRACTOR. It shall be the responsibility of the CONTRACTOR to obtain location or permits for its disposal. The price bid for trench excavation and backfill, or site excavation and regrade, shall include the cost of disposition of excess excavated materials, as set forth herein, with no additional compensation being allowed for hauling.

b. For water line and sewage force main contracts where sod is destroyed in areas maintained equivalent to residence yards, it shall be replaced on slightly ridged backfill on trench, and where destroyed in areas adjacent to the trench, it shall be replaced by the CONTRACTOR with fresh sod, all of which will be paid for at a unit price bid per foot of pipeline. The timing of resodding shall be controlled by the ENGINEER. Ground shall be prepared and fertilized as herewith specified for seeded areas. In small patches, supplying of 3 inches of topsoil and raking may be substituted for disking.

c. For plant or site based contracts, sodding shall be placed to the extent shown on the Drawings. Refer to Section 32 9200 of these Specifications for detailed instructions for the placement of sod. The cost for sodding of site based areas shall be included in the lump sum bid for the project.

d. Where pastures, thin grass or cover crops are destroyed by trenching, laying, backfilling, or tunneling operations, surface shall be prepared by disking, fertilizing, and seeding, as specified in Section 32 9200. Seeding and fertilizing shall be included in the price for trenching and backfilling. The timing of this operation

shall be controlled by the ENGINEER. Requirements of the Department of Highways for reseeding shall take precedence over these Specifications where they are involved.

e. No extra charge shall be made for backfilling of any kind, except as specified. Backfilling shall be included as a part of the price for trenching. No extra charge shall be made for supplying outside materials for backfill except where fills above existing ground are necessary and payment is designated on Drawings or in Specifications. If backfilling of the trench or surface restoration is not properly completed, a proportionate part of the unit price for trenching shall be retained from payment estimates.

f. Before completion of the Contract, all backfills shall be reshaped, holes filled, and surplus materials hauled away and all permanent walks, street, driveways, and highway paving and sod replacement (if such surface replacement items are included in the Contract) and reseeding performed.

g. Backfill material must be uniformly ridged over trench, and excess hauled away. Ridged backfill shall be confined to the width of the trench and not allowed to overlap onto firm original earth, and its height shall not be in excess of needs for replacement of settlement of backfill.

h. All rock, including crushed rock or gravel from construction, must be removed from yards and fields. Streets and walks shall be broomed to remove all earth and loose rock immediately following backfilling.

2. Special Requirements

a. In case of street, highway, railroad, sidewalk, and driveway crossings or within any roadway paving, or about manholes, valve and meter boxes located in such paving, the following backfill material and procedure is required.

b. The pipe shall be bedded in 4 inches minimum depth (for pipe sizes through 16 inches) of crushed rock meeting the requirements of the Kentucky Department of Highways standard size No. 9. For pipe sizes greater than 16 inches in diameter, the pipe bedding shall be a minimum depth of 1/4 the pipe diameter and be of the material and gradation specified previously.

c. Similar material shall be used for haunching up to the spring line of the pipe, and it shall be worked under the haunch of the pipe to provide adequate side support. The crushed rock shall then be hand placed to a point 12 inches above the top of the pipe.

d. After the above bedding and selected backfill have been placed, fill trench to within 6 inches of the surface with Kentucky Department of Highways No. 57 crushed stone, uniformly distributed, or other gradation acceptable to the ENGINEER. In order to accommodate compacted temporary surfacing it may be necessary to bulkhead or otherwise confine the stone fill at the open end of the trench.

e. Temporary surfacing of street, highway, railroad, sidewalk, and driveway crossings, or within any roadway paving, or about manholes, valve and meter boxes located in such paving, shall consist of 6 inches compacted dense graded aggregate as specified under Section 32 1123 for temporary walkway or road surfacing, placed and compacted in the trench. Compaction shall be accomplished by methods which shall be sufficient to confine stone to the trench under normal traffic. Backfills shall be maintained easily passable to traffic at original paving level until acceptance of project or replacement of paving or sidewalks.

f. Railroad Company and Department of Highways requirements in regard to backfilling will take precedence over the above general specifications where they are involved.

J. Cut-Ins, Tie-Ins, and Cutting and Plugging

1. The OWNER shall not be responsible for extra costs of cut-ins, tie-ins, cutting and plugging, due to water not being entirely cut off by the existing water main valves.

2. A cut-in is defined as the removal of one section of existing pipeline (2 cuts of pipe) and insertion of one or more new pipeline connections therein.

3. A tie-in is defined as the removal of an existing plug or cap and the connecting of the new pipeline into the existing pipeline or fitting or valve at the joint opened by such removal.

4. A cutting and plugging is defined as the cutting and installation of a plug in an existing line.

3.03 FIELD QUALITY CONTROL

A. Testing Polyvinyl Chloride (PVC) Pressure Pipe During Construction Period

1. Prior to pressure testing the pipe shall be center loaded with backfill to prevent arching and whipping under pressure. Center loading shall be done carefully so that joints will be completely exposed for examination during testing unless conditions warrant complete backfill before testing.

2. During the general construction period the following pressure testing procedure shall be followed (on sections that can be separately isolated):

    a. After the PVC pipe is assembled in the trench a test of not more than 30 percent above the system's anticipated working pressure shall be applied with either air or water. After 2 consecutive tests have been performed without any failure, the CONTRACTOR at his option and with the ENGINEER'S permission may discontinue testing until the system is completed. Testing shall then be performed as outlined herein in this Section.

B. Testing Water and Sewage Force Main Piping for Leakage

1. The CONTRACTOR will be required to test all pipelines and appurtenances with water. The maximum test pressure, measured at the lowest elevation of the pipeline being tested, shall be the pressure class of the pipe unless a specific test pressure is shown on the Drawings.

2. Prior to testing, the line shall be filled with water and any entrapped air in the line removed. This may be accomplished at a service tap for water service or air release valve. In any case, the CONTRACTOR shall be responsible for removal of air from the system at no additional cost to the OWNER.

3. When the line or section being tested is pumped up to the required pressure, it shall be valved off from the pump and a pressure gauge placed in the line. The pressure drop in the line, if any, shall be noted. If no pressure drop is noted in 4 hours, the ENGINEER, at his discretion, may accept the line or section as being tested, or he may require the test run the full 24 hours.

4. At the end of the 24 hour test period, the pressure shall be recorded. If there is a drop in pressure, the CONTRACTOR will be required to pump the section being tested up to initial test pressure and maintain that pressure for 24 hours, measuring the amount of water required to accomplish this. The line will not be accepted until the leakage shall prove to be less than 10 gallons per inch diameter per mile of pipe per 24 hours. The 24 hour test shall be charted by timed pressure recorder.

5. Should there be leakage over the allowable amount, the CONTRACTOR will be required to locate and repair the leaks and retest the section.

6. If the leakage of a section of pipeline being tested is below the allowable amount, but a leak is obvious, in the opinion of the ENGINEER, due to water at the surface of the ground, or any other means of determining a leak, the CONTRACTOR will be required to repair those leaks.

7. The CONTRACTOR shall furnish meter and suction tank, pipe test plugs, and bypass piping, and make all connections for conducting the above tests. The pumping equipment used shall be centrifugal pump, or other pumping equipment which will not place shock pressures on the pipeline. Power plunger or positive displacement pumps will not be permitted for use on closed pipe system for any purpose.

8. Inspection of pipe laying shall in no way relieve the CONTRACTOR of the responsibility for passing tests or correcting poor workmanship.

C. Disinfection (Water Mains and Services)

1. Upon completion of the work and cleaning up, and prior to final acceptance, the CONTRACTOR shall disinfect all water lines constructed which are to carry treated water.

2. Prior to starting disinfection, all water mains must be thoroughly flushed to remove mud, rocks, etc. Disinfection will then be accomplished by the adding of a chlorine solution while filling the main to obtain the initial 50 ppm of chlorine. The CONTRACTOR shall supply all equipment, labor, etc., necessary for flushing and disinfecting the mains. The CONTRACTOR shall submit, in writing, to the ENGINEER, the method he proposes to use for adding the chlorine.

3. The calcium hypochlorite granule or tablet method shall not be used. The placement of small amounts of disinfectant material in the main during construction will not be allowed.

4. Disinfection shall be accomplished by filling the new and/or repaired portions of the system with water having a chlorine content of at least 50 parts per million and at the end of a 24 hour contact time a residual of at least 25 parts per million shall remain. At the end of the 24 hour contact period, all the sterilized surfaces and areas shall be thoroughly flushed from the water system. Chlorinated water shall be disposed of in accordance with 401 KAR 5:031 and 8:020, which state that the allowable in stream concentration of chlorine is 10 ug/l, which is equal to 0.01 mg/l. The CONTRACTOR shall submit, in writing to the ENGINEER, the method he proposes for dechlorinating. Recommended chemicals, as given in AWWA C651, are sulfur dioxide, sodium bisulfate, sodium sulfite, and sodium thiosulfate.

5. For tie-ins to an existing system such as tapping valves or direct cut-in, disinfection shall, at the ENGINEER'S discretion, consist of thoroughly cleaning the new part(s) with a solution containing not less than 200 mg/l (ppm) chlorine.

6. After initial disinfection and flushing, the OWNER will collect water samples for bacteriological testing. A core zone, which includes up to the

first 1/2 mile, shall be established. Two samples shall be taken from the core zone. Additionally, 1 sample taken from each mile of new distribution main shall be taken for analysis. A new or routine replacement main shall not be placed in service until negative laboratory results are obtained on the bacteriological analyses. Sample bottles shall be clearly identified as "special" construction tests. If any of the samples are found to be positive or contain confluent growth, the CONTRACTOR shall repeat the disinfection procedure until the required numbers of negative samples are obtained.

7. The new water main(s) shall not be accepted by the OWNER for operation until the above sterilization procedures have been completed. The cost of sterilization/dechlorination procedures shall be incorporated into the CONTRACTOR'S unit price and/or lump sum bid, as the case may be.

3.04 BASIS OF PAYMENT

A. Excavation and Backfilling

1. Trenching, Laying, and Backfilling Pipelines

a. Unit Price Contracts

(1) Payment for trenching and backfilling for pressure lines shall be included in the unit price bid for furnishing and installing the pipe, measured by the linear feet installed, including fittings and accessories length.

b. Lump Sum Contracts

(1) The CONTRACTOR'S lump sum bid shall include all costs for trenching, laying and backfilling pipelines.

2. Solid Rock Excavation

a. Classified Excavation

(1) Rock excavation shall be paid for at an extra unit price per cubic yard for extra cost of its excavation over that for excavating earth. Therefore, its quantity will not be subtracted from earth excavation quantities.

b. Unclassified Excavation

(1) Excavation shall be unclassified and the cost of all excavation of whatever nature and state, including solid rock, shall be included in the CONTRACTOR'S unit price bid for each item of construction requiring excavation or included in the lump sum bid for such type contracts.

3. Search and Extra Depth Trench Excavation

   a. "Search" trench excavation shall be the actual measured excavation within limits as acceptable to the ENGINEER.

   b. "Extra Depth" trench excavation shall be the calculated yardage below the lowest point of excavation which would normally have been required for construction.

   c. Trench width limitations for either condition shall be as listed in the following table:

For 6" Pipe 2'-6"	For 16" Pipe 2'-11"	For 36" Pipe 5'-6"
For 8" Pipe 2'-9"	For 18" Pipe 3'-2"	For 42" Pipe 6'-0"
For 10" Pipe 2'-9"	For 20" Pipe 3'-5"	For 48" Pipe 6'-6"
For 12" Pipe 2'-9"	For 24" Pipe 3'-8"	For 54" Pipe 7'-0"
For 14" Pipe 2'-9"	For 30" Pipe 4'-4"	

   d. The work of uncovering and backfilling required for locating existing sewers, water lines and other existing facilities for avoidance in location of proposed pipelines where such uncovering and backfilling is not within trench for improvements, shall be paid for at a price per cubic yard for such excavation actually removed and backfilled under item for “Search or Extra Depth Trench Excavation.” Such payment does not include uncovering existing utility lines for their protection during or after trenching operations for the proposed pipeline.

   e. Where pipelines, force mains and sewers are laid in the same trench, the CONTRACTOR shall receive full trenching and backfill unit prices for each pipeline, force main and sewer so laid, the same as if laid in widely separated trenches.

4. Mechanical Tamping

   a. Mechanical tamping is defined as backfill placed and compacted by power driven mechanical equipment to a greater density than can be achieved by natural settlement or hand tamping methods. Mechanical tamping will be required when ordered by the ENGINEER with payment by the cubic yard so compacted. Measurement, but not actual extent of the mechanical tamping, shall be limited by the numerical maximum allowable trench width (for each size pipe) as shown in the table listed under "Search and Extra Depth Trench." Payment for mechanical tamping shall not

include the specified bedding, haunching, or initial backfill required above and below the top of pipe.

B. Tunneling, Boring or Jacking

1. Permanent Tunnels

a. The payment for permanent tunnels shall be the length measured along its centerline from the entrance face on one side to the exit face on the other side of the tunnel. Payment per linear foot for each size tunnel shall include excavation, tunnel liner, pressure grouting, tunnel subgrade, closure plates and backfilling, complete.

2. Temporary Tunnels

a. Payment for temporary tunnels shall be made per linear foot based on the measured distance along the centerline of tunnel from the inlet face on one side to the outlet face on the other side of the tunnel. Payment shall include all excavation, backfilling and all sheeting and shoring of tunnel, regardless of whether removed.

3. Boring or Jacking

a. In unit price Contracts, usable holes either bored or jacked shall be paid for per linear foot of hole actually bored or jacked, according to the diameter of the hole required, measured along the centerline from the point of entrance on one side to the point of exit on the other side. When cover pipe is installed inside the bore, boring or jacking and cover pipe shall be paid per linear foot based on the length of the cover pipe installed, according to the diameter of the cover pipe required.

C. Trench and Pipe Stabilization

1. Extra Excavation

a. Extra excavation required for trench or pipe stabilization shall be paid by the cubic yard so excavated under the item "Search and/or Extra Depth Trench Excavation" based on the limitations for that item.

2. Crushed Stone for Trench Stabilization

a. Crushed stone ordered by the ENGINEER for trench stabilization shall be as specified in Section 32 1123 of these Specifications and paid by the ton so placed.

3. Crushed Stone for Pipe Bedding

a. Additional crushed stone bedding ordered by the ENGINEER for pipe stabilization shall be as specified in Section 32 1123 of these Specifications and paid by the ton so placed.

4. Plain or Reinforced Concrete Arch

a. Plain or reinforced concrete arch called for on the Drawings and/or ordered by the ENGINEER shall be paid for by the linear foot of pipeline upon which it is placed. The Form of Proposal will indicate which method is to be used.

5. Plain or Reinforced Concrete Cradle

a. Plain or reinforced concrete cradle called for on the Drawings and/or ordered by the ENGINEER shall be paid for by the linear foot so placed.

D. Water Lines or Sewage Force Mains

1. Unit Price Contracts

a. Water Lines or Sewage Force Mains

(1) Payment for furnishing, trenching, bedding, laying, and backfilling water lines or force mains shall be included in the unit price bid per linear foot of pipe laid, including length of fittings and valves, unless same are included in lump sum portions or assemblies noted on the Drawings. However, payments will not be made for branch lengths of fittings within 2.5 feet of edge of main trench. The extra cost of trenching in difficult locations, such as stream, railroad, and highway crossings, if not covered in other contract unit prices, shall be included in unit price for furnishing, trenching, bedding, laying, and backfilling the pipe.

(2) All blowoff or vent branches will be measured as pipe from center of connecting tee to end of pipe.

(3) In the case of unit price contracts, ductile iron fittings, laid outside lump sum assemblies, will be included in the unit price bid per linear foot of pipe laid, including the length of fittings and valves, for the pipe in which the fitting is installed. If stated otherwise in the Special Conditions, ductile iron fittings, laid outside lump sum assemblies, will be paid for by the pound of body castings, without joint accessories, at the weights listed in ANSI/AWWA

C110/A21.10 or ANSI/AWWA C1534/A21.53 in the case of ductile iron compact fittings.

2. Lump Sum Contracts

a. All work shall be included in the CONTRACTOR'S lump sum bid.

E. Excess Materials

1. The unit prices for trench excavation, tunneling and backfill shall include the cost of disposition of excess excavated materials.

F. Valves

1. The unit price bid for the installation of valves shall include valve boxes, the cost of the concrete collar required around the valve boxes and extension stems if required.

G. Testing and Purging

1. The unit price bid for installing pressure lines shall include cleaning, purging, and testing the line.

H. Blocking of Bends and End of Pipe

1. The payment for blocking of bends and ends of pipes shall be included in the price bid for furnishing and laying the pipe.

I. Disinfection and Dechlorination

1. The required disinfection of pipelines followed by disposal of the chlorinated water used in the disinfection process shall be included in the price bid for furnishing and laying the pipe.

J. Tracing Wire or Tape

1. The cost of tracing wire or tape installed with nonmetallic pipe shall be included in the price bid for furnishing and installing the pipe.

END OF SECTION

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SECTION 33 4213

STORM SEWER

PART 1 GENERAL

1.01 SUMMARY

A. The work covered by this section shall consist of furnishing, laying, jointing storm sewer pipe and fittings, and furnishing and installation of manholes, catch basins, area drains, and other structures incidental to the construction of storm sewers.

1.02 RELATED SECTIONS

A. Section 31 2000–Moving

B. Section 03 3000–Cast-in-Place Concrete (Minor Structures)

PART 2 PRODUCTS

2.01 GENERAL

A. The diameter of pipe culverts and storm drains shown on the project drawings and bid schedule are based on Manning's formula for pipe flowing full, and the slopes shown on the drawings and profiles. Any alternative materials and types of pipe culverts and storm drains will be indicated on project drawings or shall be approved by ENGINEER during the bid phase of project by written addendum.

B. Storm drains shall have a Manning’s roughness coefficient (n-value) not greater than 0.013.

2.02 STORM PIPE MATERIALS

A. All piping materials shall have a Manning’s roughness coefficient (“n”) no greater than 0.013.

B. Reinforced Concrete Pipe (RCP): All concrete pipe shall be Class III (unless otherwise noted on plans) reinforced concrete pipe conforming to ASTM C76. Horizontal elliptical shall conform to C-507 Class HE-III.

C. High Density Polyethylene Pipe (HDPE), smaller than 12 inches in diameter: Pipe and appurtenances shall be high density polyethylene conforming to the requirements of AASHTO M294, Type S, or ASTM F 2306 as applicable. The pipe shall have a smooth interior and annular-corrugated exterior or profile wall pipe smooth interior for large diameter pipe. Polyethylene pipe materials shall be high-density polyethylene meeting ASTM D 3350 minimum cell classification 435400C. The use of reground materials is not allowed.

D. Polyvinylchloride (PVC) Pipe: PVC storm pipe, less than 12-inch interior diameter, shall meet the requirements of ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints.

E. The CONTRACTOR shall require the manufacturer or supplier furnish a certification that all materials furnished meet the above listed standards and materials specifications. A copy of this certification shall be provided to the ENGINEER.

2.03 STORM PIPE ACCESSORIES

A. Joint Materials

1. Butyl Mastic Joints or Rubber Gasket for RCP: “Soil-Tight” joints for RCP may be accomplished by using a butyl mastic sealant or a rubber gasket in the joint. The butyl mastic joint material shall meet the requirements of AASHTO M 198 (Type B). The rubber gasket joint material shall meet the physical property requirements set forth in ASTM 443.

2. Rubber “O” Ring or Profile Gasket Joints for RCP: The bell and spigot or the tongue and groove of the pipe shall be specially manufactured and prepared for the type of joint selected. The rubber gaskets shall meet the requirements of ASTM C443. Rubber gasket joints per ASTM C 443 will only be required in installations that require a watertight joint. RCP will be used on all watertight systems.

3. O-Ring Rubber Gasket Joints for HDPE: Joints shall consist of a bell and spigot type joint with an O-ring rubber gasket meeting the requirements of ASTM F477. All HDPE installations will require a rubber gasket meeting the above requirements.

4. Rubber O-Ring Gasket Joints for PVC: Joints shall consists of a bell and spigot type joint with an O-Ring rubber gasket meeting the requirements of ASTM F477.

2.04 STRUCTURES AND APPURTENANCES

A. Catch basins, manholes, and area drains shall be precast or cast-in-place concrete as shown on the Plans or as otherwise directed by the ENGINEER. Round Precast concrete structures shall meet the applicable requirements of ASTM C478 with a minimum f’c= 4,000 psi. Square and or Rectangular precast concrete structures shall meet ASTM C 913. Cast-in-place structures shall be minimum f’c=4,000 psi.

B. Grates, Frames, And Curb Castings: Conforming to the requirements of ASTM A-48, Class 30. Machining of contact surfaces will be required so that covers and grates rest securely on the frames.

C. Ladder Bars: Shall be made of aluminum alloy conforming to Federal Specification QQ-A-200/8.

D. Steps for Storm Manholes and Catch Basins: Steps shall conform to ASTM C 478 and shall be steel reinforced copolymer polypropylene with the materials conforming to the following:

1. The deformed steel reinforcing bar shall be 1/2-inch conforming to ASTM A-615 Grade 60.

2. The copolymer polypropylene shall conform to ASTM D4101 PP0344B33534Z02.

E. Mortar: Shall be composed of one part Portland cement and 2 parts sand (volumetric measure). Mortar that has been mixed for more than 30 minutes which has been retempered or which has "set" shall not be used in the work.

F. Headwalls and End Sections: Shall be precast concrete as shown on the Plans or as otherwise directed by the ENGINEER.

G. Radius Slotted Pipe Drains: Shall be galvanized steel slotted pipe, 8-inch diameter with median duty galvanized frame and galvanized steel grate meeting ADA requirements. Radius slotted pipe drain shall be as manufactured by Dura Trench or approved equal.

PART 3 EXECUTION

3.01 PIPELINE CONSTRUCTION

A. Carefully protect all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electric lines, or other utilities or structures in the vicinity of the work from damage at all times. Wherever it is necessary for the proper accomplishment of the work to repair, remove, and/or replace any utility or structure, do so in accordance with the provisions set forth in the General and Supplementary Conditions and in Division 1, General Requirements.

B. Before constructing or placing joints, demonstrate to the ENGINEER, by completing at least one sample joint, that the methods employed conform to the specifications and will provide a watertight joint if a watertight system is specified on the plans, and further that the workmen intended for use on this phase of the work are thoroughly familiar and experienced with the type of joint proposed.

C. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as provided in Section 31 2000, Earthwork.

D. Tightly stretch a mason's line or wire above the ground level, parallel to and directly above the axis of the pipe to be installed; this line is to be supported at intervals of no more than 50 feet on sewers being laid on a grade of 2 percent or more and not exceeding 25 feet for grades of less than 2 percent. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place. Accurately place each pipe to the exact

line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batter boards. The use of laser beams will be allowed.

E. Do not allow water to run or stand in the trench while pipe laying is in progress, before the joint has completely set, or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.

F. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have been started, and bring them to exact line and grade with compacted earth as necessary.

G. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells or grooves upgrade.

H. When bell and spigot pipe is utilized bell holes shall be excavated and be large enough to allow ample room for the pipe joints to be properly made. Cut bell holes out not more than 10 joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel will rest on a solid foundation for its entire length. Lay each pipe joint so as to form a close concentric joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.

I. Jointing operations shall follow pipe laying very closely; failure to comply with this provision will result in the ENGINEER stopping all pipe laying operations until jointing operations catch up.

J. (For watertight installations only) After the joints have been completed, they shall be inspected, tested, and accepted by the ENGINEER before they can be covered. The CONTRACTOR shall immediately repair any leaks or defects discovered at any time after completion of the work. Take up any pipe that has been disturbed after joints were formed; clean and remake the joints; and relay the pipe at the CONTRACTOR'S expense. Carefully protect all pipe in place from damage until backfill operations are completed.

K. Required trench widths, bedding materials, structural backfill materials, and compaction requirements for trench backfill and structural backfill for the various piping products called for in the plan documents are set forth on the project drawing detail sheet or are included and attached at the end of this section of specifications.

L. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the ENGINEER.

M. As the work progresses, thoroughly clean the interior of all pipe in place. On small pipe, keep a swab or drag in the pipeline, and pull forward past each joint immediately after it has been made. After laying each line of pipe, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.

3.02 JOINT CONSTRUCTION

A. Butyl Mastic Joints: Apply butyl mastic material on spigot or tongue of pipe section installed prior to homing bell or groove end of next pipe section.

B. Rubber “O” Ring and Profile Joints (for Watertight Installations with RCP): Rubber gaskets and the method of joint construction shall form a flexible watertight seal and shall be in strict compliance with the manufacturer's directions and requirements. Adequately lubricate the gaskets with lubricant provided for this purpose. Pipe joints shall be adequately and thoroughly homed until gasket has seated.

C. O-Ring Rubber Gasket Joints for HDPE: O-ring rubber gasket joints shall be placed on the spigot end at least two corrugations of the spigot must insert into the bell end.

D. Rubber O-Ring Gasket Joints for PVC: O-Ring rubber gaskets installed according to ASTM D 3034 for elastomeric gasket joints.

3.03 CONNECTIONS

A. Make connections to all existing sewer lines as shown on the Plans or as directed by the ENGINEER. Make connections either by removing a section of the sewer from the existing line and inserting in the space a wye branch of the proper size or by constructing a manhole, junction box, regulator chamber, or other structure as shown on the Plans.

B. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing structure, inserting a length of pipe into the hole, filling around the pipe with concrete or mortar, and troweling the inside and outside surfaces of the joint to a neat finish, without excessive projection of pipe which may impair hydraulic performance. Shape or reshape the bottoms of manholes as necessary to fit the invert of the sewer pipe.

3.04 PIPE PROTECTION

A. If pipe sewer has less than 1 foot of cover when completed, provide concrete protection as shown on the drawings or required by the ENGINEER. Place the protection in accordance with the Plans. PVC and HDPE installations must meet minimum cover as specified in Trench Details.

3.05 INSTALLATION OF STRUCTURES AND APPURTENANCES

A. Construct inlets to the sizes, shapes, and dimensions shown on the drawings or as directed by the ENGINEER to meet special conditions. Excavate for structures in accordance with the applicable provisions of Section 31 2000, Earth Moving.

B. Where inlets are to be constructed in existing pavements and/or curbs and gutters, cut such pavements and/or curbs and gutters to a neat line with an air hammer or other suitable equipment, removing no more pavement and/or curb and gutter than is essential.

C. Protect inlet foundations from damage by water and/or other causes. Place no concrete until the trench has been freed from water and/or mud, and maintain the trench in a reasonably dry condition during the progress of construction on structures.

D. When the foundation has been prepared and is approved by the ENGINEER, construct the bottom to the required line and grade. After the bottom has been allowed to set for a period of no less than 24 hours, construct the inlet thereon, taking care to form the pipe or pipes into the walls at the required elevations.

E. Set all castings accurately to line and grade in full cement mortar beds. Unless otherwise shown on the Plans and/or directed by the ENGINEER, set all grate frames no less than 1 inch below the normal grade of surrounding pavement and no less than 3 inches below the normal surface of unpaved areas; then slope the surrounding area to the grates on an approximate slope of 12:1. Mount frame in grout, secured to the top cone section to the elevation as indicated on the Plans.

F. After the frames have time to set, but in no case less than 24 hours, the space around the drainage structure shall be backfilled and compacted to the required grade and as specified in Section 31 2000, Earth Moving.

G. Install headwalls and/or end sections as shown on the Plans and in accordance with the manufacturer's specifications.

H. Install radius slotted pipe drains per manufacturer's recommendations.

1. Slotted pipe shall discharge at the end through 8-inch SDR 35 PVC pipe into drainage structure.

2. Minimum slotted pipe slope shall be 0.5 percent.

3. Slotted pipe drain shall follow the radius of the adjacent face of curb.

3.06 SUBMITTALS AND FIELD QUALITY CONTROL

A. The CONTRACTOR shall submit to the ENGINEER certification and test data to assure all pipes supplied will meet the following criteria:

B. Pipe Materials: Manufacturer shall provide certification that all materials meet or exceed Part 2 Products**,** Article 2.02 Sewer Pipe Materials. Test data regarding pipe materials and or pipe strength may be requested by the ENGINEER or OWNER.

C. Installation Deflection Requirements for HDPE

1. After the backfilling and the embankment are complete and no sooner than 7 days after the embankment is complete an independent testing firm shall be employed by the contractor to perform deflection and alignment tests on each line of pipe. For pipes 24-inch diameter and smaller this test shall be preformed using a nine-vane mandrel with a diameter that is 5 percent less than the nominal inside diameter. The mandrel vanes shall be equally spaced around the center core. The CONTRACTOR at his own expense shall replace any line of pipe, through which the mandrel does not freely pass.

2. A mandrel test as prescribed above will also be required no earlier than 30 days prior to expiration of project warranty period, release of any performance bonds, or final acceptance by the OWNER. Any line of pipe, through which the mandrel does not freely pass, shall be replaced at the CONTRACTOR's expense.

3. Pipes larger than 30-inch diameter may be tested by a mandrel as described above or they may have their deflection and alignment checked by field measurements under the supervision of the engineer. If diameter measurements are taken in lieu of pulling a mandrel through the line, then each pipe shall be measured at the joint and at a distance of 1/3 the length from each end. The CONTRACTOR at his own expense shall replace any pipe. Large diameter pipes will be checked and approved 7 days after embankment is complete and no earlier than 30 days prior to final acceptance by OWNER, expiration of warranty period, or release of any performance bond.

3.07 CLEANUP

A. After completing each section of sewer line, remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

B. The interior of catch basins, area drains, and manholes shall be cleaned of debris and excess material, the grating or cover placed, and all unused material, equipment, tools, and debris removed from the area.

END OF SECTION

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SECTION 33 4922

STORM SEWER UNDERGROUND DETENTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. The work covered by this section shall consist of furnishing and installing a complete storm sewer underground detention system including storage chambers, connecting manifolds, inlet and discharge connections, storm water quality units and other structures, materials, and fittings incidental to the construction of storm sewer underground detention systems.

1.02 RELATED SECTIONS

A. Section 05 5600–Castings

B. Section 31 2000–Earth Moving

C. Section 32 1123–Crushed Stone and Dense Graded Aggregate (DGA)

D. Section 31 0519–Geotextiles

E. Section 31 2513–Erosion Prevention and Sediment Control

F. Section 33 4213–Storm Sewer

G. Section 03 3010–Cast-in-Place Concrete (Minor Structures)

1.03 PERFORMANCE CRITERIA

A. Provide a complete storm sewer underground detention system complying with the following:

1. Required Storage

   0.75 acre-feet for detention, elevation 984.0 to 990.0
   0.25 acre-feet for water quality, elevation 981.0 to 984.0
   0.12 acre-feet for water quality by manufactured unit

2. Storage Vertical and Horizontal Constraints

   a. Adjustments to the proposed site drainage system (storm piping connecting curb inlets to underground detention system) are allowed to accommodate the proposed detention system subject to approval by the Project Engineer. Any adjustments to the proposed site drainage system will be at no cost to the OWNER. See Item 3 below for additional constraints.

3. Traffic loading: H-20. Allow minimum 18 inches from top of storage limits to final surface elevations. Stone backfill over storage chambers shall allow for stable subgrade.

4. Storage chambers shall have positive slope to drain to the discharge locations.

5. Water quality components shall remove 80 percent TSS for the 1.45 acres of new impervious area and 10.55 acres of existing impervious area.

6. Underground detention systems shall be designed and installed to include sufficient personnel access points to allow for visual inspection and maintenance of the entire system and also comply with all applicable laws and regulations (including OSHA) regarding confined space access and occupation.

1.04 DESIGN RESPONSIBILITIES

A. The proposed underground detention system shall be designed by an engineer licensed in the Commonwealth of Kentucky based on the criteria listed above, these contract documents and applicable local, state, and federal regulations. In these specifications, the underground detention system design engineer shall be noted as “system engineer.”

B. Drawings and details for the proposed underground detention system shall be stamped by the system engineer and submitted for review. Drawings and details shall include, but are not limited to, layout and dimensions, elevations, placement and connections details, installation and backfill requirements, materials used and compatibility with its various components and the proposed storm sewer system.

PART 2 PRODUCTS

2.01 GENERAL

A. Selection of products for the storm sewer underground detention system shall be selected from manufacturer’s available products and materials based on the underground detention system design requirements and these documents.

B. Products shall be demonstrated to be compatible either by being part of a manufacturer’s comprehensive system or through the system design and drawings.

C. Products shall comply with manufacturer’s standards and recommendations and as included in this section.

D. Storage chambers and storage pipes shall be a minimum of 36 inches measured in the vertical dimension. Access shall be through standard (24 inches minimum diameter) frame and lid and access structure shall be a minimum of 48 inches interior diameter. Provide access steps.

2.02 STORAGE CHAMBER MATERIALS

A. High-Density Polyethylene (HDPE) Corrugated Wall Stormwater Collection Chambers: Chambers and appurtenances shall be approved by IAPMO Research and testing as accredited by ANSI, and be manufactured in an ISO 9001:2008 certified facility.

B. Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers: Chambers and appurtenances shall comply with ASTM F 2418 and ASTM F 2787.

C. The CONTRACTOR shall require the manufacturer or supplier to furnish a certification that all materials furnished meet the above listed standards and materials specifications.

2.03 STORAGE CHAMBER ACCESSORIES

A. Joint materials listed below are for water-tight joints. If the proposed system utilizes perforated pipe or the stone backfill for storage volume, water-tight joints are not required.

1. O-Ring Rubber Gasket Joints for HDPE: Joints shall consist of a bell and spigot type joint with an O-ring rubber gasket meeting the requirements of ASTM F477. All HDPE installations will require a rubber gasket meeting the above requirements.

2. Joint materials for polypropylene (PP) corrugated wall stormwater collection chambers shall comply with manufacturer’s recommendations.

2.04 STRUCTURES AND APPURTENANCES

A. Access Lids and Frames: Conforming to the requirements of ASTM A-48, Class 30. Machining of contact surfaces will be required so that covers and grates rest securely on the frames.

B. Ladder Bars and or Steps: Shall be made of aluminum alloy conforming to Federal Specification QQ-A-200/8.

2.05 STORM WATER QUALITY UNITS

A. Provide storm water quality units compatible with system selections and of materials complying with those used for storage chambers. Units shall have necessary access points to allow for ease of maintenance, cleaning and monitoring.

B. Storm water quality units shall have documented results in meeting the Total Suspended Solids removal requirements. Supplier shall document suitability for the proposed use and ability to meet water quality removal requirements.

2.06 MISCELLANEOUS MATERIALS

A. Stone Backfill and Bedding: Provide stone backfill and bedding as recommend by the manufacturer and system engineer. If stone backfill is used for storage volume, provide washed, open graded stone to provide void requirements for the system.

B. Geotextile Filter Fabric: Where open graded stone is used for backfill, install geotextile filter fabric at stone/soil interface and around perforated piping. See Specification Section 31 0519 for geotextile requirements for woven and nonwoven materials.

PART 3 EXECUTION

3.01 GENERAL

A. Storm sewer underground detention system shall be installed per manufacturer's recommendations, the drawings and details prepared by the system engineer and the approved shop drawings. Installation of said system shall be carefully coordinated with the grading and drainage activities of the surrounding work.

B. Coordinate locations and elevations of connections to the site drainage system prior to installation of the underground detention system. Report any conflicts to the project Engineer.

C. No sediment laden storm water runoff will be allowed to discharge to the underground detention system. CONTRACTOR shall maintain erosion and sediment control measures in the contributing drainage watershed until all areas have been stabilized with vegetation or asphalt pavement.

D. The underground detention system and storm water quality units will not be accepted as completed until all areas of new construction contributing storm water runoff to the system is complete and stabilized, the non-paved areas have established vegetation, all paved areas completed and the underground storage chambers and storm water quality unit have been cleaned of all sediment and debris to as-new condition.

3.02 INSTALLATION

A. Install system according to approved system drawings and specifications.

B. Excavate and fill area to provide proper elevations and slopes to comply with approved system drawings. Removal, placement, and compaction of material to comply with Section 31 2000, Earth and Rock Work.

C. Stage grading work to prevent intrusion of sediment laden storm water runoff from entering underground detention system.

D. Install geotextile filter fabric at interface of open-graded stone and soil.

3.03 CONNECTION TO SITE DRAINAGE SYSTEM

A. Use joint materials compatible with underground detention system and site drainage system for connecting the system pipes and structures.

B. Connect proposed site drainage system only after measures are in place to prevent sediment laden storm water from discharging into the underground detention system.

3.04 SYSTEM PROTECTION

A. Provide adequate cover and project of installed materials and products. Add stone cover if required to accommodate construction traffic. Damage products and/or materials will be replaced. Replacement of damaged materials is the sole responsibility of the contractor.

3.05 SUBMITTALS AND FIELD QUALITY CONTROL

A. The CONTRACTOR shall submit to the ENGINEER certification and test data to assure all pipes supplied will meet the following criteria:

1. Storage Chamber Materials: Manufacturer shall provide certification that all materials meet or exceed Part 2 Products section 2.02 Storage Chamber Materials. Test data regarding pipe materials and or pipe strength may be requested by the ENGINEER or OWNER.

2. Installation: CONTRACTOR shall submit to the ENGINEER a certification from the system engineer that the system has been installed in compliance with the approved system design.

3.06 CLEANUP

A. After completion of system, remove all debris and construction materials from the area.

B. The interior of storage chambers and storm water quality units shall be cleaned for all sediment, trash, and other materials. Filtering medium used in the storm water quality units will be replaced or installed initially after construction in the contributing watershed has been completed.

END OF SECTION

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