PROJECT MANUAL

REBID- Fulton Reception and Diagnostic Center HVAC Improvements

Fulton Reception and Diagnostic Center

Fulton, Missouri

Designed By: Henderson Engineers, Inc.
8345 Lenexa Dr.
Lenexa, KS 66214

Date Issued: August 28, 2026

Project No.: C2406-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION

Facilities Management, Design and Construction

SECTION 000107 - PROFESSIONAL SEALS AND CERTIFICATIONS

PROJECT NUMBER: C2406-01 " STATE OF MISSOURI – REBID – FULTON RECEPTION AND DIAGNOSTIC CENTER HVAC IMPROVEMENTS"

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

ARCHITECTURAL

The documents intended to be authenticated by my seal are limited to:

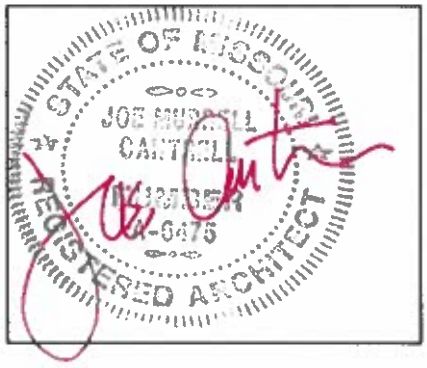
Specifications: Section 040120.63 and 042613
Section 055000
Section 061000
Division 07 all Sections
Division 09 all Sections

Drawings Sheets: AD101, A100, A110, A111, A120, A121, A122 A201, A202, A400

I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part of the project.

By: _____

Joe Cantrell, Architect
(Div. 04, 05, 06, 07, & 09 as noted above)



STRUCTURAL

The documents intended to be authenticated by my seal are limited to:

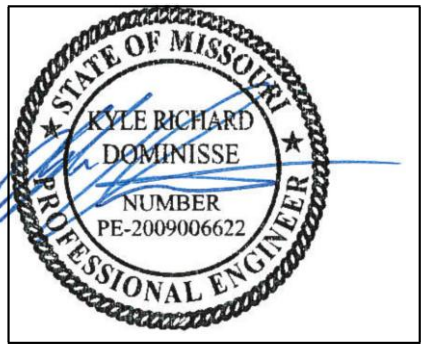
Specifications: Section 042213
Section 051200

Drawings Sheets: S000, S001, S101, S102D, S102L, S200, S500

I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part of the project.

By: _____

Kyle Dominisse, P.E. (Div. 04 & 05 as noted above)



MECHANICAL & PLUMBING

The documents intended to be authenticated by my seal are limited to:

Specifications: Division 22 all Sections
Division 23 all Sections

Drawings Sheets: M000, MD101.Bb, MD101.Bc, MD101.D, MD101.L, MD101.N, MD103.D, MD103.L, M101.Bc, M101.D, M101.L, M101.N, M102.Bb, M102.D, M102.L, M103.Bb, M103.D, M103.L, M400, M401, M500, M600, P000, P101, P102, P103.B, P103.D, P103.L, P500

I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part of the project.

By: _____

Kelley P. Cramm, P.E. (Div. 22 and 23)

8/27/2026

ELECTRICAL

The documents intended to be authenticated by my seal are limited to:

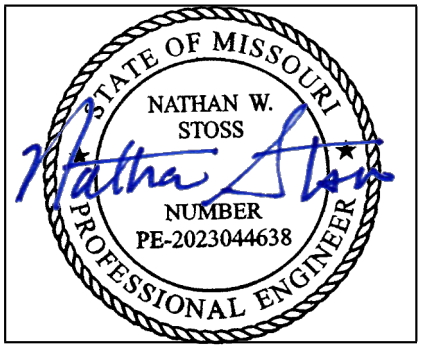
Specifications: Division 26 all Sections

Drawings Sheets: E000, E001, ED102.D, ED102.L, ED201.Bb, ED201.Bc, ED201.D, ED201.L, ED301.N, E100, E102.D, E102.L, E201.Bb, E201.Bc, E201.D, E201.L, E210, E301.D, E301.L, E301.N, E303.D, E303.L, E600, E601, E602, E603, E800, E801, E802, E803, E804, E805, E806, E900

I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part of the project.

By: _____

Nathan W. Stoss, P.E. (Div. 26)



8/27/2026

FIRE PROTECTION

The documents intended to be authenticated by my seal are limited to:

Specifications: Division 28 all Sections

Drawings Sheets: FA000, FA100, FA101.Aa, FAD101.Ab, FAD101.Ba, FAD101.Bb, FAD101.Bc, FAD101.C, FAD101.D, FAD101.HU, FAD101.I, FAD101.J, FAD101.L, FAD101.N, FAD101.O, FAD101.P, FAD102.D, FAD102.L, FAD102.N, FA101.Aa, FA101.Ab, FA101.Ba, FA101.Bb, FA101.Bc, FA101.C, FA101.D, FA101.HU, FA101.I, FA101.J, FA101.L, FA101.N, FA101.O, FA101.P, FA102.Ba, FA102.Bb, FA102.Bc, FA102.D, FA102.L, FA102.N, FA500

I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part of the project.

By: _____

Christopher J. Culp, P.E. (Div. 28)

TABLE OF CONTENTS

SECTION	TITLE	NUMBER OF PAGES
DIVISION 00 – PROCUREMENT AND CONTRACTING INFORMATION		
000000	**INTRODUCTORY INFORMATION**	
000101	Project Manual Cover	1
000107	Professional Seals and Certifications	4
000110	Table of Contents	3
000115	List of Drawings	5
001116	**INVITATION FOR BID (IFB)**	1
002113	**INSTRUCTIONS TO BIDDERS**	7
004000	**PROCUREMENT FORMS & SUPPLEMENTS**	
004113	Bid Form	*
004322	Unit Prices Form	*
004337	MBE/WBE/SDVE/HDVE Compliance Evaluation Form	*
004338	MBE/WBE/SDVE/HDVE Eligibility Determination Form for Joint Ventures	*
004339	MBE/WBE/SDVE/HDVE Good Faith Effort (GFE) Determination Forms	*
004340	SDVE Business Form	
004340.1	HDVE Business Form	*
004541	Affidavit of Work Authorization	*
004545	Anti-Discrimination Against Israel Act Certification form	*
005000	**CONTRACTING FORMS AND SUPPLEMENTS**	
005213	Construction Contract	3
006000	**PROJECT FORMS**	
006113	Performance and Payment Bond	2
006325	Product Substitution Request	2
006519.16	Final Receipt of Payment and Release Form	1
006519.18	MBE/WBE/SDVE/HDVE Progress Report	2
006519.21	Affidavit of Compliance with Prevailing Wage Law	1
007000	**CONDITIONS OF THE CONTRACT**	
007213	General Conditions	20
007300	Supplementary Conditions	1
007346	Wage Rate	4
DIVISION 01 - GENERAL REQUIREMENTS		
011000	Summary of Work	3
012100	Allowances	3
012200	Unit Prices	2
012300	Alternates	2
012600	Contract Modification Procedures	2
013100	Coordination	4

NOTICE TO BIDDERS

The following procurement forms can be found on our website at:
https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans
and shall be submitted with your bid to FMDCBids@oa.mo.gov

013115	Project Management Communications	4
013200	Schedules-Bar Chart	4
013300	Submittals	9
013513.16	Site Security and Health Requirements (DOC)	7
015000	Construction Facilities and Temporary Controls	12
017400	Cleaning	3
017900	Demonstration and Training	5
DIVISION 02 – EXISTING CONDITIONS		
024850	Lawns and Grasses	4
DIVISION 04 – MASONRY		
040120.63	Brick Masonry Repair	4
042213	Structural Reinforced Concrete Unit Masonry	16
042613	Masonry Veneer	8
DIVISION 05 – METALS		
051200	Structural Steel Framing	18
055000	Metal Fabrications	7
DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES		
061000	Rough Carpentry	5
DIVISION 07 – THERMAL AND MOISTURE PROTECTION		
070150.19	Preparation for Reroofing	5
072100	Thermal Insulation	3
072726	Air and Vapor Barriers	5
075216	Hybrid Modified Bitumen Roof System	13
075423	Thermoplastic-Polyolefin (TPO) Roofing	9
076200	Sheet Metal Flashing and Trim	9
079200	Joint Sealants	3
079216	Pick-Proof Joint Sealants	3
DIVISION 09 - FINISHES		
092216	Non-Structural Metal Framings	5
092900	Gypsum Board	5
099123	Painting	17
099656	Interior Epoxy Coatings	7
DIVISION 20 – SEISMIC CONTROLS		
200548	Seismic Controls for MEPFT	15
DIVISION 22 - PLUMBING		
220010	General Plumbing Requirements	19
220500	Common Work Results for Plumbing	6
220515	Basic Piping Materials and Methods	8
220516	Expansion Fittings and Loops for Plumbing Piping	3
220529	Hangers and Supports for Plumbing Piping	15
220548	Seismic Controls for Plumbing Systems	1
220553	Identification for Plumbing Piping and Equipment	6
227000	Natural Gas Systems	14
DIVISION 23 - MECHANICAL		
230010	General Mechanical Requirements	15
230015	Electrical Coordination for Mechanical Equipment	3
230500	Common Work Results for HVAC	9
230510	Basic Piping Materials and Methods	12

230513	Common Motor Requirements for HVAC Equipment	8
230529	Hangers and Supports for HVAC Piping and Equipment	17
230548	Seismic Controls for Mechanical	1
230553	Identification for HVAC Piping and Equipment	7
230593	Testing, Adjusting, & Balancing for HVAC	10
230700	HVAC Insulation	17
230913	Instrumentation and Control Devices for HVAC	22
230914	Refrigerant Monitoring Systems	5
230923	Direct Digital Control for HVAC	40
232113	Hydronic Piping	8
2321113.23	Mechanically Joined Hydronic Piping Systems	14
232300	Refrigerant Piping	11
233113	Metal Ducts	20
233300	Air Duct Accessories	13
233713	Diffusers, Registers and Grilles	4
236423	Scroll Water Chillers	11
237333	Indoor Indirect-Fired Heating & Ventilating Units	10
237413	Outdoor Packaged Heating and Cooling Units	10

DIVISION 26 - ELECTRICAL

260010	General Electrical Requirements	24
260500	Common Work Results for Electrical	10
260502	Equipment Wiring Systems	3
260519	Low Voltage Electrical Power Conductors and Cables	10
260526	Grounding and Bonding for Electrical Systems	10
260529	Hangers and Supports for Electrical Systems	8
260533	Raceway and Boxes for Electrical Systems	14
260543	Underground Ducts and Raceways for Electrical Systems	6
260548	Seismic Controls for Electrical Systems	2
260553	Identification for Electrical Systems	8
260573	Power System Studies	9
261200	Medium Voltage Transformers	7
262416	Panelboards	12
262726	Wiring Devices	6
262813	Fuses	4
262816	Enclosed Switches	7
264313	Surge Protective Devices	8

DIVISION 28 – FIRE DETECTION AND ALARM

284600	Fire Detection and Alarm	24

APPENDIX

1	Structural Calculations	62

SECTION 000115 – LIST OF DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

B. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 LIST OF DRAWINGS

C. The following list of drawings is a part of the Bid Documents:

	TITLE	SHEET #	DATE	CAD #
1.	Cover Sheet	G000	8/28/26	G000
2.	Overall Site Plan	A100	8/28/26	A100
3.	Roof Demolition Plans	AD101	8/28/26	AD101
4.	Level 1 Plans & Building Elevations	A110	8/28/26	A110
5.	Level 1 Plans & Building Elevations	A111	8/28/26	A111
6.	Roof Plan Building B and Details	A120	8/28/26	A120
7.	Roof Plans – Buildings D	A121	8/28/26	A121
8.	Roof Plans – Buildings L	A122	8/28/26	A122
9.	Level 2 RCP – Building D	A201	8/28/26	A201
10.	Level 2 RCP – Building L	A202	8/28/26	A202
11.	Building Sections and Details	A400	8/28/26	A400
12.	General Notes	S000	8/28/26	S000
13.	General Notes	S001	8/28/26	S001
14.	Roof Plan – Building B – Area A	S101	8/28/26	S101
15.	Roof Plan – Building D	S102D	8/28/26	S102D
16.	Roof Plan – Building L	S102L	8/28/26	S102L
17.	Structural Details	S200	8/28/26	S200
18.	Framing Details	S500	8/28/26	S500
19.	Mechanical General Notes and Legend	M000	8/28/26	M000
20.	HVAC – Level 1 Demo Plan – Building B – Area B	MD101.Bb	8/28/26	MD101.Bb
21.	HVAC – Level 1 Demo Plan – Building B – Area c	MD101.Bc	8/28/26	MD101.Bc

22.	HVAC – Level 1 Demo Plan – Building D	MD101.D	8/28/26	MD101.D
23.	HVAC – Level 1 Demo Plan – Building L	MD101.L	8/28/26	MD101.L
24.	HVAC – Level 1 Demo Plan – Building N Housing Unit 8	MD101.N	8/28/26	MD101.N
25.	HVAC – Roof Demo Plan-Building D	MD103.D	8/28/26	MD103.D
26.	HVAC – Roof Demo Plan-Building L	MD103.L	8/28/26	MD103.L
27.	HVAC – Level 1 Plan – Building B – Area C	M101.Bc	8/28/26	M101.Bc
28.	HVAC – Level 1 Plan – Building D	M101.D	8/28/26	M101.D
29.	HVAC – Level 1 Plan – Building L	M101.L	8/28/26	M101.L
30.	HVAC – Level 1 Plan – Building N Housing Unit 8	M101.N	8/28/26	M101.N
31.	HVAC – Level 2 Plan – Building B – Area B	M102.Bb	8/28/26	M102.Bb
32.	HVAC – Level 2 Plan – Building D	M102.D	8/28/26	M102.D
33.	HVAC – Level 2 Plan – Building L	M102.L	8/28/26	M102.L
34.	Mechanical Roof Plan – Building B – Area B	M103.Bb	8/28/26	M103.Bb
35.	Mechanical Roof Plan – Building D	M103.D	8/28/26	M103.D
36.	Mechanical Roof Plan – Building L	M103.L	8/28/26	M103.L
37.	Mechanical Schedules	M400	8/28/26	M400
38.	Mechanical Schedules	M401	8/28/26	M401
39.	Mechanical Details	M500	8/28/26	M500
40.	Mechanical Controls	M600	8/28/26	M600
41.	Plumbing General Notes and Legend	P000	8/28/26	P000
42.	Plumbing Site Plan – South	P101	8/28/26	P101
43.	Plumbing Site Plan – North	P102	8/28/26	P102
44.	Plumbing Roof Plan – Building B	P103.B	8/28/26	P103.B
45.	Plumbing Roof Plan – Building D	P103.D	8/28/26	P103.D
46.	Plumbing Roof Plan – Building L	P103.L	8/28/26	P103.L
47.	Plumbing Details and Schedules	P500	8/28/26	P500
48.	Electrical Legend	E000	8/28/26	E000
49.	Electrical General Notes	E001	8/28/26	E001
50.	Electrical Plan – Overall	E100	8/28/26	E100
51.	Lighting – Level 2 Demo Plan –			

	Building D	ED102.D	8/28/26	ED102.D
52.	Lighting – Level 2 Demo Plan – Building L	ED102.L	8/28/26	ED102.L
53.	Power – Level 1 Demo Plan – Building B – Area B	ED201.Bb	8/28/26	ED201.Bb
54.	Power – Level 1 Demo Plan – Building B – Area C	ED201.Bc	8/28/26	ED201.Bc
55.	Power – Level 1 Demo Plan – Building D	ED201.D	8/28/26	ED201.D
56.	Power – Level 1 Demo Plan – Building L	ED201.L	8/28/26	ED201.L
57.	Equipment Connection – Level 1 Demo Plan – Building N	ED301.N	8/28/26	ED301.N
58.	Lighting – Level 2 Plan – Building D	E102.D	8/28/26	E102.D
59.	Lighting – Level 2 Plan – Building L	E102.L	8/28/26	E102.L
60.	Power – Level 1 Plan – Building B – Area B	E201.Bb	8/28/26	E201.Bb
61.	Power – Level 1 Plan – Building B – Area C	E201.Bc	8/28/26	E201.Bc
62.	Power – Level 1 Plan – Building D	E201.D	8/28/26	E201.D
63.	Power – Level 1 Plan – Building L	E201.L	8/28/26	E201.L
64.	Power Plan – Unique Conditions	E210	8/28/26	E210
65.	Equipment Connection – Level 1 – Building D	E301.D	8/28/26	E301.D
66.	Equipment Connection – Level 1 – Building L	E301.L	8/28/26	E301.L
67.	Equipment Connection – Level 1 – Building N	E301.N	8/28/26	E301.N
68.	Equipment Connection Roof Plan – Building D	E303.D	8/28/26	E303.D
69.	Equipment Connection Roof Plan – Building L	E303.L	8/28/26	E303.L
70.	Panelboard Schedules	E600	8/28/26	E600
71.	Panelboard Schedules	E601	8/28/26	E601
72.	Panelboard Schedules	E602	8/28/26	E602

73.	Panelboard Schedules	E603	8/28/26	E603
74.	Electrical Medium-Voltage Oneline	E800	8/28/26	E800
75.	Electrical Line-Voltage Onelines	E801	8/28/26	E801
76.	Electrical Line-Voltage Onelines	E802	8/28/26	E802
77.	Electrical Emergency Oneline	E803	8/28/26	E803
78.	Electrical Line-Voltage Onelines	E804	8/28/26	E804
79.	Electrical Calculations	E805	8/28/26	E805
80.	Electrical Calculations	E806	8/28/26	E806
81.	Electrical Details	E900	8/28/26	E900
82.	Fire Alarm General Notes and Legend	FA000	8/28/26	FA000
83.	Fire Alarm Site Plan	FA100	8/28/26	FA100
84.	Fire Alarm Demolition – Level 1 – Building A – Area A	FAD101.Aa	8/28/26	FAD101.Aa
85.	Fire Alarm Demolition – Level 1 – Building A – Area B	FAD101.Ab	8/28/26	FAD101.Ab
86.	Fire Alarm Demolition – Level 1 – Building B – Area A	FAD101.Ba	8/28/26	FAD101.Ba
87.	Fire Alarm Demolition – Level 1 – Building B – Area B	FAD101.Bb	8/28/26	FAD101.Bb
88.	Fire Alarm Demolition – Level 1 – Building B – Area C	FAD101.Bc	8/28/26	FAD101.Bc
89.	Fire Alarm Demolition – Level 1 – Building C	FAD101.C	8/28/26	FAD101.C
90.	Fire Alarm Demolition – Level 1 – Building D	FAD101.D	8/28/26	FAD101.D
91.	Fire Alarm Demolition – Level 1 – Building HU-17	FAD101.HU	8/28/26	FAD101.HU
92.	Fire Alarm Demolition – Level 1 – Building I	FAD101.I	8/28/26	FAD101.I
93.	Fire Alarm Demolition – Level 1 – Building J	FAD101.J	8/28/26	FAD101.J
94.	Fire Alarm Demolition – Level 1 – Building L	FAD101.L	8/28/26	FAD101.L
95.	Fire Alarm Demolition – Level 1 – Building N	FAD101.N	8/28/26	FAD101.N
96.	Fire Alarm Demolition – Level 1 –			

	Building O	FAD101.O	8/28/26	FAD101.O
97.	Fire Alarm Demolition – Level 1 – Building P	FAD101.P	8/28/26	FAD101.P
98.	Fire Alarm Demolition– Level 2 – Building D	FAD102.D	8/28/26	FAD102.D
99.	Fire Alarm Demolition – Level 2 – Building L	FAD102.L	8/28/26	FAD102.L
100.	Fire Alarm Demolition – Level 2 – Building N	FAD102.N	8/28/26	FAD102.N
101.	Fire Alarm Plan – Level 1 – Building A – Area A	FA101.Aa	8/28/26	FA101.Aa
102.	Fire Alarm Plan – Level 1 – Building A – Area B	FA101.Ab	8/28/26	FA101.Ab
103.	Fire Alarm Plan – Level 1 – Building B – Area A	FA101.Ba	8/28/26	FA101.Ba
104.	Fire Alarm Plan – Level 1 – Building B – Area B	FA101.Bb	8/28/26	FA101.Bb
105.	Fire Alarm Plan – Level 1 – Building B – Area C	FA101.Bc	8/28/26	FA101.Bc
106.	Fire Alarm Plan – Level 1 – Building C	FA101.C	8/28/26	FA101.C
107.	Fire Alarm Plan – Level 1 – Building D	FA101.D	8/28/26	FA101.D
108.	Fire Alarm Plan – Level 1 – Building HU	FA101.HU	8/28/26	FA101.HU
109.	Fire Alarm Plan – Level 1 – Building I	FA101.I	8/28/26	FA101.I
110.	Fire Alarm Plan – Level 1 – Building J	FA101.J	8/28/26	FA101.J
111.	Fire Alarm Plan – Level 1 – Building L	FA101.L	8/28/26	FA101.L
112.	Fire Alarm Plan – Level 1 – Building N	FA101.N	8/28/26	FA101.N
113.	Fire Alarm Plan – Level 1 – Building O	FA101.O	8/28/26	FA101.O
114.	Fire Alarm Plan – Level 1 – Building P	FA101.P	8/28/26	FA101.P
115.	Fire Alarm Plan – Level 2 – Building D	FA102.D	8/28/26	FA102.D
116.	Fire Alarm Plan – Level 2 – Building L	FA102.L	8/28/26	FA102.L
117.	Fire Alarm Plan – Level 2 – Building N	FA102.N	8/28/26	FA102.N
118.	Fire Alarm Details	FA500	8/28/26	FA500

END OF SECTION 000115

SECTION 001116 - INVITATION FOR BID

1.0 OWNER:

A. The State of Missouri
Office of Administration,
Division of Facilities Management, Design and Construction
Jefferson City, Missouri

2.0 PROJECT TITLE AND NUMBER:

A. REBID- Fulton Reception and Diagnostic Center HVAC Improvements
Fulton Reception and Diagnostic Center
Fulton, Missouri
Project No.: C2406-01

3.0 BIDS WILL BE RECEIVED:

A. Until: 1:30 PM, November 3, 2026

B. **Only electronic bids sent to FMDCBids@oa.mo.gov shall be accepted: (See Instructions to Bidders for further detail)**

4.0 DESCRIPTION:

A. Scope: The project includes the addition of packaged rooftop units to provide cooling to dayrooms and cells in existing housing units. Modifications to electrical systems to accommodate new RTUs. Extension of natural gas service to accommodate new RTUs. Addition of structural supports to accommodate new RTUs. Modifications to ceilings/soffits/roofs to accommodate new RTUs. Full replacement of fire alarm systems in the existing Housing Units.

B. MBE/WBE/SDVE/HDVE Goals: MBE **0%**, WBE **0%**, and SDVE **3%** or HDVE **3%**. **NOTE: Only MBE/WBE firms certified by the State of Missouri Office of Equal Opportunity as of the date of bid opening, or SDVE(s)/HDVE(s)meeting the requirements of Section 34.069, RSMo, Section 34.074, RSMo and 1 CSR 30-5.010, can be used to satisfy the MBE/WBE/SDVE/HDVE participation goals for this project.**

5.0 PRE-BID MEETING:

A. Place/Time**:** 9:30 AM, October 19, 2026, at Fulton Reception and Diagnostic Center 1393 State Route O, Fulton, MO 65251 Maintenance Building.

B. Access to State of Missouri property requires presentation of a photo ID by all persons.

6.0 HOW TO GET PLANS & SPECIFICATIONS:

A. View Only Electronic bid sets are available at no cost or paper bid sets for a deposit of $200.00 from American Document Solutions (ADS). MAKE CHECKS PAYABLE TO: American Document Solutions. Mail to: American Document Solutions, 1400 Forum Blvd., Suite 7A, Columbia, Missouri 65203. Phone 573-446-7768, Fax 573-355-5433, https://www.adsplanroom.net. NOTE: Prime contractors will be allowed a maximum of two bid sets at the deposit rate shown above. Other requesters will be allowed only one bid set at this rate. Additional bid sets or parts thereof may be obtained by any bidder at the cost of printing and shipping by request to American Document Solutions at the address shown above. Bidder must secure at least one bid set to become a planholder.

B. **Refunds: Return plans and specifications in unmarked condition within 15 working days of bid opening to American Document Solutions, 1400 Forum Blvd., Suite 7A, Columbia, Missouri 65203. Phone 573-446-7768, Fax 573-355-5433. Deposits for plans not returned within 15 working days shall be forfeited.**

C. Information for upcoming bids, including downloadable plans, specifications, Invitation for Bid, bid tabulation, award, addenda, and access to the ADS planholders list, is available on the Division of Facilities Management, Design and Construction's web site: https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans.

7.0 POINT OF CONTACT:

A. Project Manager: Shannon Thompson, email: shannon.thompson@oa.mo.gov

8.0 GENERAL INFORMATION:

A. The State reserves the right to reject any and all bids and to waive all informalities in bids. No bid may be withdrawn for a period of 20 working days subsequent to the specified bid opening time. The contractor shall pay not less than the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed, as determined by the Missouri Department of Labor and Industrial Relations and as set out in the detailed plans and specifications.

B. Bid results will be available at https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans after it is verified that at least one bid is awardable and affordable.

SECTION 002113 – INSTRUCTIONS TO BIDDERS

1.0 - SPECIAL NOTICE TO BIDDERS

A. If awarded a contract, the Bidder's employees, and the employees of all subcontractors, who perform the work on the project must adhere to requirements in Section 013513 – Site Security and Health Requirements as applicable per Agency.

B. The Bidder's prices shall include all city, state, and federal sales, excise, and similar taxes that may lawfully be assessed in connection with the performance of work, and the purchased of materials to be incorporated in the work. **THIS PROJECT IS NOT TAX EXEMPT.**

2.0 - BID DOCUMENTS

A. The number of sets obtainable by one (1) party may be limited in accordance with available supply.

B. For the convenience of contractors, subcontractors and suppliers, bidding documents are available on the Owner's website at https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans.

3.0 - BIDDERS' OBLIGATIONS

A. Bidders must carefully examine the entire site of the work and shall make all reasonable and necessary investigations to inform themselves thoroughly as to the facilities available as well as to all the difficulties involved in the completion of all work in accordance with the specifications and the plans. Bidders are required to examine all maps, plans and data mentioned in the specifications. No plea of ignorance concerning observable existing conditions or difficulties that may be encountered in the execution of the work under this contract will be accepted as an excuse for any failure or omission on the part of the successful Bidder (contractor) to fulfill every detail of the requirements of the contract, nor accepted as a basis for any claims for extra compensation or time extension.

B. Under no circumstances will Bidders give their plans and specifications to other Bidders. It is highly encouraged, but not required, that all Bidders be on the official planholders list to receive project updates including but not limited to any addenda that are issued during the bidding process.

4.0 - INTERPRETATIONS

A. No Bidder shall be entitled to rely on oral or written representations from any person as to the meaning of the plans and specifications or the acceptability of alternate products, materials, form or type of construction.

B. Bidders shall make all requests for interpretations in writing and submit all requests to the Project Manager identified in Section 007300 – Supplementary Conditions with all necessary supporting documentation no less than five (5) working days before opening of bids. Responses to requests for interpretation will be issued via a written addendum and will be sent as promptly as is practicable to all official planholders and posted on the Owner's website. All such addenda shall become part of the bid and contract documents.

C. Bidders shall make all requests for an "Acceptable Substitution" on the Section 006325 Substitution Request Form. The request shall be emailed to the Project Manager identified in Section 007300 – Supplementary Conditions no less than five (5) working days before opening of bids. Responses to requests for substitutions will be issued via a written addendum and will be sent as promptly as is practicable to all official planholders and posted on the Owner's website. All such addenda shall become part of the bid and contract documents.

D. An "Acceptable Substitution" requested after the award of bid will only be approved if proven to the satisfaction of the Owner and the Designer that the product is acceptable in design, strength, durability, usefulness, and convenience for the purpose intended. Approval of the substitution after award is at the sole discretion of the Owner and all requests of this nature must be submitted in accordance with Article 3.1 of the General Conditions.

5.0 - BIDS AND BIDDING PROCEDURE

A. Bidders shall submit all submission forms and accompanying documents listed in Section 004113 – Bid Form, Article 5.0, Attachments to Bid by the stated time on the bid documents or the bid will be rejected for being non-responsive.

B. Depending on the specific project requirements, **the following is a GENERIC list** of all possible bid forms that may be due with bid submittals. Bidders must verify each specific project's requirements in Section 004113 to ensure they have provided all the required documentation with their submission.

Bid Submittal – due before stated date and time of bid opening (see IFB):

004113	Bid Form (all pages are always required)
004322	Unit Prices Form
004336	Proposed Subcontractors Form
004337	MBE/WBE/SDVE/HDVE Compliance Evaluation Form
004338	MBE/WBE/SDVE/HDVE Eligibility Determination for Joint Ventures
004339	MBE/WBE/SDVE/HDVE GFE Determination
004340	SDVE Business Form
004340.1	HDVE Business Form
004541	Affidavit of Work Authorization
004545	Anti-Discrimination Against Israel Act Certification form

C. The Bidder shall submit its bid on the forms provided by the Owner in the same file format (PDF) with each space fully and properly completed, typewritten or legibly printed, including all amounts required for alternate bids, unit prices, cost accounting data, etc. The Owner will reject bids that are not on the Owner's forms and that do not contain all requested information. All forms can be found on the Owner's website at https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans and shall be submitted to FMDCBids@oa.mo.gov.

D. All bids shall be submitted without additional terms and conditions, modifications, or reservations. The completed forms shall not include interlineations, alterations, or erasures. Bids not in compliance with the requirements of this paragraph will be rejected as non-responsive.

E. All bids shall be accompanied by a bid bond executed by the bidder and a duly authorized surety company, certified check, cashier's check or bank draft made payable to the Division of Facilities Management, Design and Construction, State of Missouri, in the amount indicated in the bid documents in Section 004113. Failure of the Bidder to submit the duly authorized bid bond or the full amount required shall be sufficient cause to reject his bid. The Bidder agrees that the proceeds of the check, draft, or bond shall become the property of the State of Missouri, if for any reason the Bidder withdraws his bid after bid closing or if the Bidder, within ten (10) working days after notification of award, refuses or is unable to 1) execute the tendered contract, 2) provide an acceptable performance and payment bond, or 3) provide evidence of required insurance coverage.

F. The bid bond check or draft submitted by the successful Bidder will be returned after the receipt of an acceptable performance and payment bond and execution of the formal contract. Checks or drafts of all other Bidders will be returned within a reasonable time after it is determined that the bid represented by same will receive no further consideration by the State of Missouri.

6.0 - SIGNING OF BIDS

A. A bid shall contain the full and correct legal name of the Bidder. If the Bidder is an entity registered with the Missouri Secretary of State, the Bidder's name on the bid form shall appear as shown in the Secretary of State's records. If the Bidder is an entity organized in a state other than Missouri, the Bidder must provide a Certificate of Authority to do business in the State of Missouri.

B. If the successful Bidder is doing business in the State of Missouri under a fictitious name, the Bidder shall furnish to Owner, attached to the Bid Form, a properly certified copy of the certificate of Registration of Fictitious Name from the State of Missouri, and such certificate shall remain on file with the Owner.

C. A bid from an individual shall be signed as noted on the Bid Form.

D. A bid from a partnership or joint venture shall require only one signature of a partner, an officer of the joint venture authorized to bind the venture, or an attorney-in-fact. If the bid is signed by an officer of a joint venture or an attorney-in-fact, a document evidencing the individual's authority to execute contracts should be included with the bid form.

E. A bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.

F. A bid from a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation. Title of office held by the person signing for the corporation shall appear, along with typed name of said individual and the corporate license number shall be provided. In addition, for corporate proposals, the President or Vice-President listed per the current filing with the Missouri Secretary of State should sign as the Bidder. If the signatory is other than the corporate president or vice president, the bidder must provide satisfactory evidence that the signatory has the legal authority to bind the corporation.

7.0 - RECEIVING BID SUBMITTALS

A. It is the Bidder's sole responsibility to ensure receipt of the bid submittals by Owner on or before the date and time specified in the Invitation for Bid or as modified via written addenda. Bids received after the date and time specified will not be considered by the Owner.

B. All bids shall be received via email at FMDCBids@oa.mo.gov. A bid submitted through any other means, including hard copies, will not be considered and will be discarded by the Owner unopened.

8.0 - MODIFICATION AND WITHDRAWAL OF BIDS

A. Bidder may withdraw a bid at any time prior to the scheduled closing time for receipt of bids, but no bidder may withdraw his bid for a period of twenty (20) working days after the scheduled closing time for receipt of bids.

B. Bidder may modify a bid until the scheduled closing time by sending a revised bid to FMDCBids@oa.mo.gov with a note in the subject line and body of the email that it is a revised bid. A revised bid sent via any other method will not be considered.

9.0 - AWARD OF CONTRACT

A. The Owner reserves the right to reject any and/or all bids and further to waive all informalities in bidding when deemed in the best interest of the State of Missouri.

B. The Owner reserves the right to let other contracts in connection with the work including, but not limited to, contracts for the furnishing and installation of furniture, equipment, machinery, appliances and other apparatuses.

C. The Owner will award a contract to the lowest, responsive, and responsible Bidder in accordance with Section 8.250, RSMo. No contract will be awarded to any Bidder who has had a contract with the Owner terminated within the preceding twelve months for material breach of contract or who has been suspended or debarred by the Owner.

D. Award of alternates, if any, will be made in numerical order unless all bids received are such that the order of acceptance of alternates does not affect the determination of the lowest, responsive, responsible bidder.

E. No award shall be considered binding upon the Owner until the written contract has been properly executed and the following documentation has been provided: 1) performance and payment bond consistent with Article 6.1 of the General Conditions; 2) proof of the required insurance coverage; 3) an executed Section 004541 - Affidavit of Work Authorization form; and 4) documentation evidence enrollment and participation in a federal work authorization program.

F. Failure to execute and return the contract and associated documents within the prescribed period shall be treated, at the option of the Owner, as a breach of Bidder's obligation and the Owner shall be under no further obligation to Bidder.

G. Transient employers subject to Sections 285.230 and 285.234, RSMo, (out-of-state employers who temporarily transact any business in the State of Missouri) may be required to file a bond with the

Missouri Department of Revenue. No contract will be awarded by the Owner unless the successful Bidder certifies that he has complied with all applicable provisions of Section 285.230-234.

H. Sections 285.525 and 285.530, RSMo, require business entities to enroll and participate in a federal work authorization program in order to be eligible to receive award of any state contract in excess of $5,000. Bidders should submit with their bid an Affidavit of Work Authorization (Section 004541) along with appropriate documentation evidencing such enrollment and participation. Bidders must also submit an E-Verify Memorandum before the Owner may award a contract to the Bidder. Information regarding E-Verify is located at https://www.e-verify.gov/employers/enrolling-in-e-verify. The contractor shall be responsible for ensuring that all subcontractors and suppliers associated with this contract enroll in E-Verify.

I. The successful Bidder must be registered in MissouriBUYS powered by MOVERS at https://missouribuys.mo.gov/supplier-registration# as an approved vendor prior to being issued a contract.

10.0 - CONTRACT SECURITY

A. The successful Bidder shall furnish a performance/payment bond as set forth in General Conditions Article 6.1 prior to the State executing the contract and issuing a notice to proceed.

11.0 - WORKING DAYS

A. Contract duration time is stated in working days and will use the following definition in determining the actual calendar date for contract completion:

1. Working days are defined as all calendar days except Saturdays, Sundays and the following State of Missouri observed holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday, Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day.

12.0 - AMERICAN AND MISSOURI - MADE PRODUCTS AND FIRMS

A. By signing the bid form and submitting a bid on this project, the Bidder certifies that it will use American and Missouri products as set forth in Article 1.7 of the General Conditions. Bidders are advised to review those requirements carefully prior to bidding.

B. A preference shall be given to Missouri firms, corporations or individuals, or firms, corporations or individuals that maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less.

C. Pursuant to Section 34.076, RSMo, a contractor or Bidder domiciled outside the boundaries of the State of Missouri shall be required, in order to be successful, to submit a bid the same percent less than the lowest bid submitted by a responsible contractor or Bidder domiciled in Missouri as would be required for such a Missouri domiciled contractor or Bidder to succeed over the bidding contractor or Bidder domiciled outside Missouri on a like contract or bid being let in the Bidder's domiciliary state and, further, the contractor or Bidder domiciled outside the boundaries of Missouri shall be required to submit an audited financial statement as would be required of a Missouri domiciled contractor or Bidder on a like contract or bid being let in the domiciliary state of that contractor or Bidder.

13.0 – ANTI-DISCRIMINATION AGAINST ISRAEL ACT CERTIFICATION:

A. If the Bidder meets the section 34.600, RSMo., definition of a "company" and the Bidder has ten or more employees, the Bidder must certify in writing that the Bidder is not currently engaged in a boycott of goods or services from the State of Israel and shall not engage in a boycott of goods or services from the State of Israel, if awarded a contract, for the duration of the contract. The Bidder is required to complete and submit the applicable portion of Section 004545 - Anti-Discrimination Against Israel Act Certification with its Bid Form. The applicable portion of the exhibit must be submitted prior to execution of a contract by the Owner and issuance of Notice to Proceed.

14.0 - MBE/WBE/SDVE/HDVE INSTRUCTIONS

A. Definitions:

1. **"MBE"** means a Minority Business Enterprise.

2. **"MINORITY"** has the same meaning as set forth in 1 CSR. 10-17.010.

3. **"MINORITY BUSINESS ENTERPRISE"** has the same meaning as set forth in section 37.020, RSMo.

4. **"WBE"** means a Women's Business Enterprise.

5. **"WOMEN'S BUSINESS ENTERPRISE"** has the same meaning as set forth in section 37.020, RSMo.

6. **"SDVE"** means a Service-Disabled Veterans Enterprise.

7. **"SERVICE-DISABLED VETERAN"** has the same meaning as set forth in section 34.074, RSMo.

8. **"SERVICE-DISABLED VETERAN ENTERPRISE"** has the same meaning as "Service-Disabled Veteran Business" set forth in section 34.074, RSMo.

9. **"HDVE" means an Honorably Discharged Veteran Enterprise**

10. **"Honorably Discharged Veteran" has the same meaning as set forth in section 34.069, RSMo.**

11. **"Honorably Discharged Veteran Enterprise"** has the same meaning as "Honorably Discharged Veteran Business" set forth in section 34.069, RSMo.

B. MBE/WBE/SDVE/HDVE General Requirements:

1. For all bids greater than $100,000, the Bidder shall obtain MBE, WBE, SDVE or HDVE participation in an amount equal to or greater than the percentage goals set forth in the Invitation for Bid and the Bid Form, unless the Bidder is granted a Good Faith Effort waiver by the Director of the Division, as set forth below. If the Bidder does not meet the MBE, WBE, SDVE or HDVE goals, or make a good faith effort to do so, the Bidder shall be nonresponsive, and its bid shall be rejected.

2. The Bidder should submit with its bid all the information requested in the MBE/WBE/SDVE/HDVE Compliance Evaluation Form for every MBE, WBE, SDVE, or HDVE subcontractor or material supplier the Bidder intends to use for the contract work. The Bidder is required to submit all MBE/WBE/SDVE/HDVE documentation before the stated time and date set forth in the Invitation for Bid. If the Bidder fails to provide such information by the specified date and time, the Owner shall reject the bid.

3. The Director reserves the right to request additional information from a Bidder to clarify the Bidder's proposed MBE, WBE, SDVE, or HDVE participation. The Bidder shall submit the clarifying information requested by the Owner within two (2) working days of receiving the request for clarification.

4. Pursuant to section 34.069, RSMo and section 34.074, RSMo, a Prime Bidder that qualifies as an SDVE or HDVE shall receive a three-percentage point bonus preference in the contract award evaluation process. The bonus preference will be calculated and applied by reducing the bid amount of the eligible SDVE or HDVE by three percent of the apparent low responsive Bidder's bid. Based on this calculation, if the eligible SDVE's or HDVE's evaluation is less than the apparent low responsive Bidder's bid, the eligible SDVE's or HDVE's bid will become the apparent low responsive bid. This reduction is for evaluation purposes only and will have no impact on the actual amount(s) of the bid or the amount(s) of any contract awarded. In order to be eligible for the SDVE or HDVE preference, the Bidder must complete and submit with its bid the Missouri Service-Disabled Veteran Business Form or the Missouri Honorably Discharged Veterans Business Form, and any information required by the form.

C. Computation of MBE/WBE/SDVE/HDVE Goal Participation:

1. A Bidder who is a MBE, WBE, SDVE, or HDVE may count 100% of the contract towards the MBE, WBE, SDVE, or HDVE goal, less any amounts awarded to another MBE, WBESDVE, or HDVE. (NOTE: a MBE firm that bids as general contractor must obtain WBE and SDVE or HDVE participation; a WBE firm that bids as a general contractor must obtain MBE and SDVE or HDVE participation; and a SDVE or HDVE firm that bids as general contractor must obtain

MBE and WBE participation.) For the remaining contract amount to be counted towards the MBE, WBE or SDVE goal, the Bidder must complete the MBE/WBE/SDVE/HDVE Compliance Evaluation Form (Section 004337) identifying itself as an MBE, WBE, SDVE or HDVE.

2. The total dollar value of the work granted to a certified MBE, WBE, SDVE or HDVE by the Bidder shall be counted towards the applicable goal.

3. Expenditures for materials and supplies obtained from a certified MBE, WBE, SDVE, or HDVE supplier or manufacturer may be counted towards the MBE, WBE, SDVE or HDVE goals, if the MBE, WBE, SDVE, or HDVE assumes the actual and contractual responsibility for the provision of the materials and supplies.

4. The total dollar value of the work granted to a second or subsequent tier subcontractor or a supplier may be counted towards a Bidder's MBE, WBE, SDVE or HDVE goals, if the MBE, WBE, SDVE or HDVE properly assumes the actual and contractual responsibility for the work.

5. The total dollar value of work granted to a certified joint venture equal to the percentage of the ownership and control of the MBE, WBE, SDVE or HDVE partner in the joint venture may be counted towards the MBE/WBE/SDVE/HDVE goals.

6. Only expenditures to a MBE, WBE, SDVE or HDVE that performs a commercially useful function in the work may be counted towards the MBE, WBE, SDVE or HDVE goals. A MBE, WBE, SDVE or HDVE performs a commercially useful function when it is responsible for executing a distinct element of the work and carrying out its responsibilities by performing, managing and supervising the work or providing supplies or manufactured materials.

D. Certification of MBE/WBE/SDVE/HDVE Subcontractors:

1. In order to be counted towards the goals, an MBE or WBE must be certified by the State of Missouri Office of Equal Opportunity and an SDVE/HDVE must be certified by the State of Missouri, Office of Equal Opportunity or by the Federal U.S. Small Business Administration directory.

2. The Bidder may determine the certification status of a proposed MBE or WBE subcontractor or supplier by referring to the Office of Equal Opportunity (OEO)'s online MBE/WBE directory https://apps1.mo.gov/MWBCertifiedFirms/. The Bidder may determine the eligibility of a SDVE/HDVE subcontractor or supplier by referring to the Office of Equal Opportunity online SDVE/HDVE directory at https://oeo.mo.gov/sdve-certification-program/ or the Federal U.S. Small Business Administration directory https://veterans.certify.sba.gov/#search.

3. Additional information, clarifications, or other information regarding the MBE/WBE/SDVE/HDVE listings in the directories may be obtained by contacting the Contract Specialist of record as shown in the Supplementary Conditions (Section 007300).

E. Waiver of MBE/WBE/SDVE/HDVE Participation:

1. If a Bidder has made a good faith effort to secure the required MBE, WBE, SDVE or HDVE participation and has failed, the Bidder shall submit with its bid the information requested in MBE/WBE/SDVE/HDVE Good Faith Effort (GFE) Determination form. The Director will determine if the Bidder made a good faith effort to meet the applicable goals. If the Director determines that the Bidder did not make a good faith effort, the bid shall be rejected as being nonresponsive to the bid requirements. Bidders who demonstrate that they have made a good faith effort to include MBE, WBE, SDVE or HDVE participation will be granted a waiver and will be considered to be responsive to the applicable participation goals, regardless of the percent of actual participation obtained, if the bid is otherwise acceptable.

2. In determining whether a Bidder has made a good faith effort to obtain MBE, WBE, SDVE or HDVE participation, the Director may evaluate the factors set forth in 1 CSR 30-5.010(6)(C) and the following:

   a. The amount of actual participation obtained;

b. How and when the Bidder contacted potential MBE, WBE, SDVE, or HDVE subcontractors and suppliers;

c. The documentation provided by the Bidder to support its contacts, including whether the Bidder provided the names, addresses, phone numbers, and dates of contact for MBE/WBE/SDVE/HDVE firms contacted for specific categories of work;

d. If project information, including plans and specifications, were provided to MBE/WBE/SDVE/HDVE subcontractors;

e. Whether the Bidder made any attempts to follow-up with MBE, WBE, SDVE or HDVE firms prior to bid;

f. Amount of bids received from any of the subcontractors and/or suppliers that the Bidder contacted;

g. The Bidder's stated reasons for rejecting any bids;

F. Contractor MBE/WBE/SDVE/HDVE Obligations

1. If awarded a contract, the Bidder will be contractually required to subcontract with or obtain materials from the MBE, WBE, SDVE, HDVE firms listed in its bid, in amounts equal to or greater than the dollar amount in the bid, unless the amount is modified in writing by the Owner.

2. If the Contractor fails to meet or maintain the participation requirements contained in the Contractor's bid, the Contractor must satisfactorily explain to the Director why it cannot comply with the requirement and why failing meeting the requirement was beyond the Contractor's control. If the Director finds the Contractor's explanation unsatisfactory, the Director may take any appropriate action including, but not limited to:

   a. Declaring the Contractor ineligible to participate in any contracts with the Division for up to twelve (12) months (suspension); and/or

   b. Declaring the Contractor be nonresponsive to the Invitation for Bid, or in breach of contract and rejecting the bid or terminating the contract.

3. If the Contractor replaces an MBE, WBE, SDVE or HDVE during the course of the contract, the Contractor shall replace it with another MBE, WBE, SDVE or HDVE or make a good faith effort to do so. All MBE, WBE, SDVE or HDVE substitutions must be approved by the Director in writing.

4. The Contractor shall provide the Owner with regular reports on its progress in meeting its MBE/WBE/SDVE/HDVE obligations. At a minimum, the Contractor shall report the dollar-value of work completed by each MBE, WBE, SDVE or HDVE during the preceding month and the cumulative total of work completed by each MBE, WBE, SDVE or HDVE to date with each monthly application for payment. The Contractor shall also make a final report, which shall include the total dollar-value of work completed by each MBE, WBE, SDVE or HDVE during the entire contract.

State of Missouri
Construction Contract

THIS AGREEMENT is made (DATE) by and between:

Contractor Name and Address

hereinafter called the "Contractor," and the **State of Missouri**, hereinafter called the **"Owner"**, represented by the Office of Administration, Division of Facilities Management, Design and Construction.

WITNESSETH, that the Contractor and the Owner, for the consideration stated herein agree as follows:

ARTICLE 1. STATEMENT OF WORK

The Contractor shall furnish all labor and materials and perform all work required for furnishing and installing all labor, materials, equipment and transportation and everything necessarily inferred from the general nature and tendency of the plans and specifications for the proper execution of the work for:

Project Name: **REBID- Fulton Reception and Diagnostic Center HVAC Improvements**
Fulton Reception and Diagnostic Center
Fulton, Missouri

Project Number: **C2406-01**

in strict accordance with the Contract Documents as enumerated in Article 7, all of which are made a part hereof.

ARTICLE 2. TIME OF COMPLETION

The contract performance time is **400 working days** from the transmittal date of this agreement. The contract completion date is **MONTH, DAY, YEAR**. This time includes ten (10) working days for the Contractor to receive, sign and return the contract form along with required bonding and insurance certificates. Failure of the Contractor to provide correct bonding and insurance within the ten (10) working days shall not be grounds for a time extension. Receipt of proper bonding and insurance is a condition precedent to the formation of the contract and if not timely received, may result in forfeiture of the Contractor's bid security. Work may not commence until the Owner issues a written Notice to Proceed and must commence within seven (7) working days thereafter.

ARTICLE 3. LIQUIDATED DAMAGES

Whenever time is mentioned in this contract, time shall be and is of the essence of this contract. The Owner would suffer a loss should the Contractor fail to have the work embraced in this contract fully completed on or before the time above specified. THEREFORE, the parties hereto realize in order to adjust satisfactorily the damages on account of such failure that it might be impossible to compute accurately or estimate the amount of such loss or damages which the Owner would sustain by reason of failure to complete fully said work within the time required by this contract. The Contractor hereby covenants and agrees to pay the Owner, as and for **liquidated damages, the sum of $1,000** per day for each and every day, Sunday and legal holidays excepted, during which the work remains incomplete and unfinished. Any sum which may be due the Owner for such damages shall be deducted and retained by the Owner from any balance which may be due the Contractor when said work shall have been finished and accepted. But such provisions shall not release the Bond of the Contractor from liability according to its terms. In case of failure to complete, the Owner will be under no obligation to show or prove any actual or specific loss or damage.

SAMPLE

ARTICLE 4. CONTRACT SUM

The Owner shall pay the Contractor for the prompt, faithful and efficient performance of the conditions and undertakings of this contract, subject to additions, and deductions as provided herein, in current funds the sum of:

Base Bid: $

Accepted Alternates, if applicable to the Project and accepted by the Owner.

TOTAL CONTRACT AMOUNT: ($CONTRACT AMOUNT)

UNIT PRICES: The Owner accepts the following Unit Prices:

For changing specified quantities of work from those indicated by the contract drawings and specifications, upon written instructions of Owner, the following unit prices shall prevail. The unit prices include all labor, overhead and profit, materials, equipment, appliances, bailing, shoring, shoring removal, etc., to cover the finished work of the several kinds of work called for. Only a single unit price shall be given and it shall apply for either MORE or LESS work than that shown on the drawings and called for in the specifications or included in the Base Bid. In the event of more or less units than so indicated or included, change orders may be issued for the increased or decreased amount.

ARTICLE 5. PREVAILING WAGE RATE

MISSOURI PREVAILING WAGE LAW (Sections 290.210 to 290.340, RSMo): The Contractor shall pay not less than the specified hourly rate of wages, as set out in the wage order attached to and made part of the specifications for work under this contract, to all workers performing work under the contract, in accordance with sections 290.210 to 290.340, RSMo. The Contractor shall forfeit a penalty to the Owner of one hundred dollars per day (or portion of a day) for each worker that is paid less than the specified rates for any work done under the contract by the Contractor or by any subcontractor, in accordance with section 290.250, RSMo.

DAVIS-BACON ACT: If this Project is financed in whole or in part from Federal funds (as indicated in the Instructions to Bidders or other bid or contract documents for this Project), then this contract shall be subject to all applicable federal labor statutes, rules and regulations, including provisions of the Davis-Bacon Act, 40 U.S.C. §3141 et seq., and the "Federal Labor Standards Provisions," as further set forth in Section 007333 – Supplementary General Conditions for Federally Funded/Assisted Construction Projects, which is incorporated into the contract by reference. Where the Missouri Prevailing Wage Law and the Davis-Bacon Act require payment of different wages for work performed under this contract, the Contractor and all Subcontractors shall pay the greater of the wages required under either law, on a classification-by-classification basis.

ARTICLE 6. MINORITY/WOMEN/SERVICE DISABLED VETERAN BUSINESS ENTERPRISE PARTICIPATION

The Contractor has been granted a waiver of the 0% MBE, 0% WBE, and 3% SDVE or HDVE 3% participation goals. The Contractor agrees to secure the MBE/WBE/SDVE/HDVE participation amounts for this project as follows: (OR)

The Contractor has met the MBE/WBE/SDVE/HDVE participation goals and agrees to secure the MBE/WBE/SDVE/HDVE participation amounts for this project as follows:

MBE/WBE/SDVE/HDVE Firm: Subcontract Amt:$
MBE/WBE/SDVE/HDVE Firm: Subcontract Amt:$
MBE/WBE/SDVE/HDVE Firm: Subcontract Amt:$
Total $

MBE/WBE/SDVE/HDVE assignments identified above shall not be changed without a contract change signed by the Owner.

The Director of the Division of Facilities Management, Design and Construction or his Designee shall be the final authority to resolve disputes and disagreements between the Contractor and the MBE/WBE/SDVE/HDVE firms listed above when such disputes impact the subcontract amounts shown above.

SAMPLE

ARTICLE 7. CONTRACT DOCUMENTS

The following documents are hereby incorporated into this contract by reference (all division/section numbers and titles are as utilized in the Project Manual published by the Owner for this Project):

1. Division 0 – Procurement and Contracting Information, including, but not limited to:
    a. Invitation for Bid (Section 001116)
    b. Instructions to Bidders (Section 002113)
    c. Supplementary Instructions to Bidders (if applicable) (Section 002213)
    d. The following documents as completed and executed by the Contractor and accepted by the Owner, if applicable:
        i. Bid Form (Section 004113)
        ii. Unit Prices (Section 004322)
        iii. Proposed Contractors Form (Section 004336)
        iv. MBE, WBE, SDVE, HDVE Compliance Evaluation Form(s) (Section 004337)
        v. MBE, WBE, SDVE, HDVE Eligibility Determination Form for Joint Ventures (Section 004338)
        vi. MBE, WBE, SDVE, HDVE Good Faith Effort (GFE) Determination Form (Section 004339)
        vii. Missouri Service-Disabled Veteran Business Form (Section 004340)
        viii. Missouri Honorably Discharged Veteran Business Form (Section 004340.1)
        ix. Affidavit of Work Authorization (Section 004541)
    e. Performance and Payment Bond, completed and executed by the Contractor and surety (Section 006113)
    f. General Conditions (Section 007213)
    g. Supplementary Conditions (Section 007300)
    h. Supplementary General Conditions for Federally Funded/Assisted Construction Projects (Section 007333), if applicable
    i. Wage Rate(s) (Section 007346)
2. Division 1 – General Requirements
3. All Drawings identified in the Project Manual
4. All Technical Specifications included in the Project Manual
5. Addenda, if applicable

ARTICLE 8 – CERTIFICATION

By signing this contract, the Contractor hereby re-certifies compliance with all legal requirements set forth in Section 6.0, Bidder's Certifications of the Bid Form.

By signature below, the parties hereby execute this contract document.

APPROVED:

_____
Crystal Wessing, Interim Director
Division of Facilities Management,
Design and Construction

_____
Contractor's Authorized Signature

I, Corporate Secretary, certify that I am Secretary of the corporation named above and that (CONTRACTOR NAME), who signed said contract on behalf of the corporation, was then (TITLE) of said corporation and that said contract was duly signed for and in behalf of the corporation by authority of its governing body, and is within the scope of its corporate powers.

_____
Corporate Secretary

SAMPLE

Bond No._____

SECTION 006113 - PERFORMANCE AND PAYMENT BOND FORM

KNOW ALL MEN BY THESE PRESENTS, THAT we _____

as principal, and _____

_____as Surety, are held and firmly bound unto the

STATE OF MISSOURI. in the sum of _____ Dollars ($)

for payment whereof the Principal and Surety bind themselves, their heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

WHEREAS, the Principal has, by means of a written agreement dated the _____

day of_____, 20_____, enter into a contract with the State of Missouri for

_____

_____

_____

(Insert Project Title and Number)

NOW, THEREFORE, if the Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the State of Missouri, with or without notice to the Surety and during the life of any guaranty required under the contract; and shall also faithfully perform and fulfill all undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made with or without notice to the Surety; and shall also promptly make payment for materials incorporated, consumed or used in connection with the work set forth in the contract referred to above, and all insurance premiums, both compensation and all other kinds of insurance, on said work, and for all labor performed on such work, whether by subcontractor or otherwise, at not less than the prevailing hourly rate of wages for work of a similar character (exclusive of maintenance work) in the locality in which the work is performed and not less than the prevailing hourly rate of wages for legal holiday and overtime work (exclusive of maintenance work) in the locality in which the work is performed both as determined by the Department of Labor and Industrial Relations or determined by the Court of Appeal, as provided for in said contract and in any and all duly authorized modifications of said contract that may be hereafter made, with or without notice to the Surety, then, this obligation shall be void and of no effect, but it is expressly understood that if the Principal should make default in or should fail to strictly, faithfully and efficiently do, perform and comply with any or more of the covenants, agreements, stipulations, conditions, requirements or undertakings, as specified in or by the terms of said contract, and with the time therein named, then this obligation shall be valid and binding upon each of the parties hereto and this bond shall remain in full force and effect; and the same may be sued on at the instance of any material man, laborer, mechanic, subcontractor, individual, or otherwise to whom such payment is due, in the name of the State of Missouri, to the use of any such person.

AND, IT IS FURTHER specifically provided that any modifications which may hereinafter be made in the terms of the contract or in the work to be done under it or the giving by the Owner of any extension of the time for the performance of the contract or any other forbearance on the part of either the Owner or the Principal to the other, shall not in any way release the Principal and the Surety, or either or any of them, their heirs, executors, administrators and successors, from their liability hereunder, notice to the Surety of any such extension, modifications or forbearance being hereby waived.

IN WITNESS WHEREOF, the above bounden parties have executed the within instrument this _____ day of _____, 20 ____.

AS APPLICABLE:

AN INDIVIDUAL

Name: _____

Signature: _____

A PARTNERSHIP

Name of Partner: _____

Signature of Partner: _____

Name of Partner: _____

Signature of Partner: _____

CORPORATION

Firm Name: _____

Signature of President: _____

SURETY

Surety Name: _____

Attorney-in-Fact: _____

Address of Attorney-in-Fact: _____

_____

Telephone Number of Attorney-in-Fact: _____

Signature Attorney-in-Fact: _____

NOTE: Surety shall attach Power of Attorney

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION

PRODUCT SUBSTITUTION REQUEST

PROJECT NUMBER

PROJECT TITLE AND LOCATION

CHECK APPROPRIATE BOX

☐ SUBSTITUTION PRIOR TO BID OPENING
(Minimum of (5) working days prior to receipt of Bids as per Article 4 – Instructions to Bidders)

☐ SUBSTITUTION FOLLOWING AWARD
(Maximum of (20) working days from Notice to Proceed as per Article 3 – General Conditions)

FROM: BIDDER/CONTRACTOR (PRINT COMPANY NAME)

TO: ARCHITECT/ENGINEER (PRINT COMPANY NAME)

Bidder/Contractor hereby requests acceptance of the following product or systems as a substitution in accordance with provisions of Division One of the Bidding Documents:

SPECIFIED PRODUCT OR SYSTEM

SPECIFICATION SECTION NO.

SUPPORTING DATA

☐ Product data for proposed substitution is attached (include description of product, standards, performance, and test data)

☐ Sample ☐ Sample will be sent, if requested

QUALITY COMPARISON

	SPECIFIED PRODUCT	SUBSTITUTION REQUEST
NAME, BRAND		
CATALOG NO.		
MANUFACTURER		
VENDOR		

PREVIOUS INSTALLATIONS

PROJECT	ARCHITECT/ENGINEER	
LOCATION		DATE INSTALLED

SIGNIFICANT VARIATIONS FROM SPECIFIED PRODUCT

REASON FOR SUBSTITUTION

DOES PROPOSED SUBSTITUTION AFFECT OTHER PARTS OF WORK?

☐ YES ☐ NO

IF YES, EXPLAIN

SUBSTITUTION REQUIRES DIMENSIONAL REVISION OR REDESIGN OF STRUCTURE OR A/E WORK

☐ YES ☐ NO

BIDDER'S/CONTRACTOR'S STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENT:

We have investigated the proposed substitution. We believe that it is equal or superior in all respects to specified product, except as stated above; that it will provide the same Warranty as specified product; that we have included complete implications of the substitution; that we will pay redesign and other costs caused by the substitution which subsequently become apparent; and that we will pay costs to modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning as a result of the substitution.

BIDDER/CONTRACTOR	DATE

REVIEW AND ACTION

☐ Resubmit Substitution Request with the following additional information:

☐ Substitution is accepted.

☐ Substitution is accepted with the following comments:

☐ Substitution is not accepted.

ARCHITECT/ENGINEER	DATE

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION

FINAL RECEIPT OF PAYMENT AND RELEASE

PROJECT NUMBER

KNOW ALL MEN BY THESE PRESENT THAT: hereinafter called "Subcontractor" who heretofore entered into an agreement with hereinafter called "Contractor", for the performance of work and/or furnishing of material for the construction of the project entitled

(PROJECT TITLE, PROJECT LOCATION, AND PROJECT NUMBER)

at

(ADDRESS OF PROJECT)

for the State of Missouri (Owner) which said subcontract is by this reference incorporated herein, in consideration of such final payment by Contractor.

DOES HEREBY:

1. ACKNOWLEDGE that they have been **PAID IN FULL** all sums due for work and materials contracted or done by their Subcontractors, Material Vendors, Equipment and Fixture Suppliers, Agents and Employees, or otherwise in the performance of the Work called for by the aforesaid Contract and all modifications or extras or additions thereto, for the construction of said project or otherwise.
2. RELEASE and fully, finally, and forever discharge the Owner from any and all suits, actions, claims, and demands for payment for work performed or materials supplied by Subcontractor in accordance with the requirements of the above referenced Contract.
1. REPRESENT that all of their Employees, Subcontractors, Material Vendors, Equipment and Fixture Suppliers, and everyone else has been **paid in full** all sums due them, or any of them, in connection with performance of said Work, or anything done or omitted by them, or any of them in connection with the construction of said improvements, or otherwise.

DATED this day of , 20 .

NAME OF SUBCONTRACTOR

BY (TYPED OR PRINTED NAME)

SIGNATURE

TITLE

ORIGINAL: FILE/Closeout Documents

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT,
DESIGN AND CONSTRUCTION

PAY APP NO.	PROJECT NUMBER
CHECK IF FINAL ☐**FINAL**	DATE

MBE/WBE/SDVE/HDVE PROGRESS REPORT

Remit with **ALL** Progress and Final Payments

(Please check appropriate box) ☐CONSULTANT ☐CONSTRUCTION

PROJECT TITLE	
PROJECT LOCATION	
FIRM	
ORIGINAL CONTRACT SUM (Same as Line Item 1. on Form A of Application for Payment) **$**	TOTAL CONTRACT SUM TO DATE (Same as Line Item 3. on Form A of Application for Payment) **$**

THE TOTAL MBE/WBE/SDVE/HDVE PARTICIPATION DOLLAR AMOUNT OF THIS PROJECT AS INDICATED IN THE ORIGINAL CONTRACT: **$**

SELECT MBE, WBE, SDVE, HDVE	ORIGINAL CONTRACT PARTICIPATION AMOUNT	PARTICIPATION AMOUNT PAID-TO-DATE (includes approved contract changes)	CONSULTANT/SUBCONSULTANT OR CONTRACTOR/SUBCONTRACTOR/SUPPLIER COMPANY NAME
☐ MBE ☐ WBE ☐ SDVE ☐ HDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE ☐ HDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE ☐ HDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE ☐ HDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE ☐ HDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE ☐ HDVE	$	$	

INSTRUCTIONS FOR MBE/WBE/SDVE/HDVE PROGRESS REPORT

CONTRACTOR OR CONSULTANT TO FILL OUT AND REMIT WITH EACH PAY APPLICATION:

The MBE/WBE/SDVE/HDVE Progress Report for the project is issued with the contract comprising values reported in the consultant's Proposal or on the successful contractor's Section 004337 Compliance Evaluation Forms.

At Initial Pay Application fill in the following:

1. Pay App No. Start with 1.
2. Fill in the Project Number and Date.
3. Enter Project Title, Project Location, and Firm.
4. Fill in the "Original Contract Sum" and "Total Contract Sum To Date" (Reference applicable Line Items on Form A of Application for Payment).
5. Indicate the Total Participation Dollar Amount from the Original Contract.
6. Select MBE, WBE, SDVE, or HDVE for each Consultant/Subconsultant or Contractor/Subcontractor/Supplier.
7. Enter the "Total Amount of Subcontract", "$ Amount (Paid-To-Date)", and Company Name.

For all subsequent Pay Applications fill in the following:

1. Pay App No.
2. If Final Pay App, check box.
3. Fill in the Project Number and Date.
4. Enter Project Title, Project Location, and Firm
5. At each Pay App fill in the "Original Contract Sum" and "Total Contract Sum To Date" (reference applicable Line Items on Form A of Application for Payment).
6. Indicate the Total Participation Dollar Amount from the Original Contract.
7. Select MBE, WBE, SDVE, or HDVE for each Consultant/Subconsultant or Contractor/Subcontractor/Supplier
8. Enter the "Total Amount of Subcontract", "$ Amount (Paid-To-Date)", and Company Name.

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION
AFFIDAVIT – COMPLIANCE WITH PREVAILING WAGE LAW

PROJECT NUMBER

Before me, the undersigned Notary Public, in and for the County of _____

State of _____ personally came and appeared _____
(NAME)

_____ of the _____
(POSITION) (NAME OF THE COMPANY)

(a corporation) (a partnership) (a proprietorship) and after being duly sworn did depose and say that all provisions and requirements set out in Chapter 290, Sections 290.210 through and including 290.340, Missouri Revised Statutes, pertaining to the payment of wages to workmen employed on public works project have been fully satisfied and there has been no exception to the full and completed compliance with said provisions and requirements and with Wage Determination No: _____ issued by the Department of Labor and Industrial Relations, State of Missouri on the _____ day of _____ 20 __ in carrying out the contract and working in connection with _____
(NAME OF PROJECT)

Located at _____ in _____ County
(NAME OF THE INSTITUTION)

Missouri, and completed on the _____ day of _____ 20 __

SIGNATURE

NOTARY INFORMATION

NOTARY PUBLIC EMBOSSER OR BLACK INK RUBBER STAMP SEAL	STATE		COUNTY (OR CITY OF ST. LOUIS)
	SUBSCRIBED AND SWORN BEFORE ME, THIS DAY OF YEAR		**USE RUBBER STAMP IN CLEAR AREA BELOW**
	NOTARY PUBLIC SIGNATURE	MY COMMISSION EXPIRES	
	NOTARY PUBLIC NAME (TYPED OR PRINTED)		

FILE: Closeout Documents

GENERAL CONDITIONS

INDEX

ARTICLE:

1. General Provisions

1.1. Definitions

1.2. Drawings and Specifications

1.3. Compliance with Laws, Permits, Regulations and Inspections

1.4. Nondiscrimination in Employment

1.5. Anti-Kickback

1.6. Patents and Royalties

1.7. Preference for American and Missouri Products and Services

1.8. Communications

1.9. Separate Contracts and Cooperation

1.10. Assignment of Contract

1.11. Indemnification

1.12. Disputes and Disagreements

2. Owner/Designer Responsibilities

3. Contractor Responsibilities

3.1. Acceptable Substitutions

3.2. Submittals

3.3. As-Built Drawings

3.4. Guaranty and Warranties

3.5. Operation and Maintenance Manuals

3.6. Other Contractor Responsibilities

3.7. Subcontracts

4. Changes in the Work

4.1. Changes in the Work

4.2. Changes in Completion Time

5. Construction and Completion

5.1. Construction Commencement

5.2. Project Construction

5.3. Project Completion

5.4. Payments

6. Bond and Insurance

6.1. Bond

6.2. Insurance

7. Termination or Suspension of Contract

7.1. For Site Conditions

7.2. For Cause

7.3. For Convenience

A. These General Conditions apply to each section of these specifications. The Contractor is subject to the provisions contained herein.

B. The General Conditions are intended to define the relationship of the Owner, the Designer and the Contractor thereby establishing certain rules and provisions governing the operation and performance of the work so that the work may be performed in a safe, orderly, expeditious and workmanlike manner.

ARTICLE 1 – GENERAL PROVISIONS

ARTICLE 1.1 - DEFINITIONS

As used in these contract documents, the following terms shall have the meanings and refer to the parties designated in these definitions.

1. **"COMMISSIONER":** The Commissioner of the Office of Administration.
2. **"CONSTRUCTION DOCUMENTS":** The "Construction Documents" shall consist of the Project Manual, Drawings and Addenda.
3. **"CONSTRUCTION REPRESENTATIVE:"** Whenever the term "Construction Representative" is used, it shall mean the Owner's Representative at the work site.
4. **"CONTRACTOR"**: Party or parties who have entered into a contract with the Owner to furnish work under these specifications and drawings.
5. **"DESIGNER"**: When the term "Designer" is used herein, it shall refer to the Architect, Engineer, or Consultant of Record specified and defined in Paragraph 2.0 of the Supplemental Conditions, or his duly authorized representative. The Designer may be either a consultant or state employee.
6. **"DIRECTOR"**: Whenever the term "Director" is used, it shall mean the Director of the Division of Facilities Management, Design and Construction or his Designee, representing the Office of Administration, State of Missouri. The Director is the agent of the Owner.
7. **"DIVISION":** Shall mean the Division of Facilities Management, Design and Construction, State of Missouri.
8. **"INCIDENTAL JOB BURDENS":** Shall mean those expenses relating to the cost of work, incurred either in the home office or on the job-site, which are necessary in the course of doing business but are incidental to the job. Such costs include office supplies and equipment, postage, courier services, telephone expenses including long distance, water and ice and other similar expenses.
9. **"JOINT VENTURE"**: An association of two (2) or more businesses to carry out a single business enterprise for profit for which purpose they combine their property, capital, efforts, skills and knowledge.
10. **"OWNER"**: Whenever the term "Owner" is used, it shall mean the State of Missouri. Acting by and through the Office of Administration, Division of Facilities Management, Design and Construction.
11. **"PROJECT"**: Wherever the term "Project" is used, it shall mean the work required to be completed by the construction contract.
12. **"PROJECT MANUAL"**: The "Project Manual" shall consist of Introductory Information, Invitation for Bid, Instructions to Bidders, Bid Documents, Additional Information, Standard Forms, General Conditions, Supplemental General Conditions, General Requirements and Technical Specifications.
13. **"SUBCONTRACTOR"**: Party or parties who contract under, or for the performance of part or this entire Contract between the Owner and Contractor. The subcontract may or may not be direct with the Contractor.
14. **"WORK"**: All supervision, labor, materials, tools, supplies, equipment, and any incidental operations and/or activities required by or reasonably inferable from the Contract Documents necessary to construct the Project and to produce the results intended by the Contract Documents in a safe, expeditious, orderly, and workmanlike manner so that the project shall be complete and finished in the best manner known to each respective trade.
15. "**WORKING DAYS**": are all calendar days except Saturdays, Sundays and the following holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday (observed), Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day (observed), Thanksgiving Day, Christmas Day.

ARTICLE 1.2 DRAWINGS AND SPECIFICATIONS

A. In case of discrepancy between drawings and specifications, specifications shall govern. Should discrepancies in architectural drawings, structural drawings and mechanical drawings occur, architectural drawings shall govern and, in case of conflict between structural and mechanical drawings, structural drawings shall govern.

B. Specifications are separated into titled divisions for convenience of reference only and to facilitate letting of contracts and subcontracts. The Contractor is responsible for establishing the scope of work for subcontractors, which may cross titled divisions. Neither the Owner nor Designer will establish limits and jurisdiction of subcontracts.

C. Figured dimensions take precedence over scaled measurements and details over smaller scale general drawings. In the event of conflict between any of the documents contained within the contract, the documents shall take precedence and be controlling in the following sequence: addenda, supplementary general conditions, general conditions, division 1 specifications, technical division specifications, drawings, bid form and instructions to bidders.

D. Anything shown on drawings and not mentioned in these specifications or vice versa, as well as any incidental work which is obviously necessary to complete the project within the limits established by the drawings and specifications, although not shown on or described therein, shall be performed by the Contractor at no additional cost as a part of his contract.

E. Upon encountering conditions differing materially from those indicated in the contract documents, the Contractor shall promptly notify the Designer and Construction Representative in writing before such conditions are disturbed. The Designer shall promptly investigate said conditions and report to the Owner, with a recommended course of action**.** If conditions do materially differ and cause an increase or decrease in contract cost or time required for completion of any portion of the work, a contract change will be initiated as outlined in Article 4 of these General Conditions.

E. Only work included in the contract documents is authorized, and the Contractor shall do no work other than that described therein or in accordance with appropriately authorized and approved contract changes.

ARTICLE 1.3 - COMPLIANCE WITH LAWS, PERMITS, REGULATIONS AND INSPECTIONS

A. Since the Owner is the State of Missouri, municipal or political subdivisions, zoning ordinances, construction codes (other than licensing of trades), and other like ordinances are not applicable to construction on Owner's property, and Contractor will not be required to submit drawings and specifications to any municipal or political subdivision, authority, obtain construction permits or any other licenses (other than licensing of trades) or permits from or submit to inspections by any municipality or political subdivision relating to the construction for this project. All permits or licenses required by municipality or political subdivision for operation on property not belonging to Owner shall be obtained by and paid for by Contractor. Each Contractor shall comply with all applicable laws, ordinances, rules and regulations that pertain to the work of this contract.

B. Contractors, subcontractors and their employees engaged in the businesses of electrical, mechanical, plumbing, carpentry, sprinkler system work, and other construction related trades shall be licensed to perform such work by the municipal or political subdivision where the project is located, if such licensure is required by local code. Local codes shall dictate the level (master, journeyman, and apprentice) and the number, type and ratio of licensed tradesmen required for this project within the jurisdiction of such municipal or political subdivision.

C. Equipment and controls manufacturers and their authorized service and installation technicians that do not maintain an office within the jurisdiction of the municipal or political subdivision but are a listed or specified contractor or subcontractor on this project are exempt from Paragraph 1.3 B above.

D. The Contractor shall post a copy of the wage determination issued for the project and included as a part of the contract documents, in a prominent and easily accessible location at the site of construction for the duration of the project.

E. Any contractor or subcontractor to such contractor at any tier signing a contract to work on this project shall provide a ten-hour Occupational Safety and Health Administration (OSHA) construction safety program for their on-site employees which includes a course in construction safety and health approved by OSHA or a similar program approved by the Department of Labor and Industrial Relations which is at least as stringent as an approved OSHA program. The contractor shall forfeit as a penalty to the public body on whose

behalf the contract is made or awarded, two thousand five hundred dollars plus one hundred dollars for each employee employed by the contractor or subcontractor, for each calendar day, or portion thereof, such employee is employed without the required training.

ARTICLE 1.4 - NONDISCRIMINATION IN EMPLOYMENT

A. The Contractor and his subcontractors will not discriminate against individuals based on race, color, religion, national origin, sex, disability, or age, but may use restrictions which relate to bona fide occupational qualifications. Specifically, the Contractor and his subcontractors shall not discriminate:

1. Against recipients of service on the basis of race, color, religion, national origin, sex, disability or age.
2. Against any employee or applicant, for employment on the basis of race, color, religion, national origin, sex or otherwise qualified disability status.
3. Against any applicant for employment or employee on the basis of age, where such applicant or employee is between ages 40 and 70 and where such Contractor employs at least 20 persons.
4. Against any applicant for employment or employee on the basis of that person's status as a disabled or Vietnam-era veteran.

The Contractor and his Subcontractors will ensure applicants for employment and employees are treated equally without regard to race, color, religion, national origin, sex, disability, or age. Such action shall include, but not be limited to, the following: employment, upgrading, demotion and transfer; recruitment or recruitment advertising; and selection for training, including apprenticeship. The Contractor and his Subcontractors will give written notice of their commitments under this clause to any labor union with which they have bargaining or other agreements under this clause to any labor union with which they have bargaining or other agreements.

B. In the event of the Contractor's or his subcontractor's noncompliance with any provisions of this Article of the Contract, the Owner may cancel this contract in whole or in part or require the Contractor to terminate his contract with the subcontractor.

ARTICLE 1.5 - ANTI-KICKBACK

No employee of the division, shall have or acquire any pecuniary interest, whether direct or indirect, in this contract or in any part hereof. No officer, employee, designer, attorney, or administrator of or for the Owner who is authorized in such capacity and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the project, shall have or acquire any pecuniary interest, whether direct or indirect, in this contract, any material supply contract, subcontract, insurance contract, or any other contract pertaining to the project.

ARTICLE 1.6 - PATENTS AND ROYALTIES

A. The Contractor shall hold and save the Owner and its officers, agents, servants, and employees harmless from liabilities of any nature or kind, including cost and expenses, for, or on account of, any patented or unpatented invention, process, article or appliance manufactured or used in the performance of this contract, including its use by the Owner, unless otherwise specifically stipulated in the contract documents.

B. If the Contractor uses any design, device or materials covered by letters, patent or copyright, the Contractor shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device or material. It is mutually agreed and understood, without exception, that the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this contract and shall indemnify the Owner for any cost, expense or damage it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

ARTICLE 1.7 - PREFERENCE FOR AMERICAN AND MISSOURI PRODUCTS AND SERVICES

A. By virtue of statutory authority a preference will be given to Missouri labor and to products of mines, forests and quarries of the state of Missouri when they are found in marketable quantities in the state, and all such materials shall be of the best quality and suitable character that can be obtained at reasonable market prices, all as provided for in Section 8.280, Missouri Revised Statutes and Cumulative Supplements.

B. Furthermore, pursuant to Section 34.076 Missouri Revised Statutes and Cumulative Supplements, a preference shall be given to those persons doing business as Missouri firms, corporations, or individuals, or which maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less. In addition, in order for a non-domiciliary bidder to be successful, his bid must be that same percentage lower than a domiciliary Missouri bidder's bid, as would be required for a Missouri bidder to successfully bid in the non-domiciliary state.

C In accordance with the Missouri Domestic Products Procurement Act Section 34.350 RSMo and Cumulative Supplements any manufactured goods or commodities used or supplied in the performance of this contract or any subcontract thereto shall be manufactured, assembled or produced in the United States, unless the specified products are not manufactured, assembled or produced in the United States in sufficient quantities to meet the agency's requirements or cannot be manufactured, assembled or produced in the United States within the necessary time in sufficient quantities to meet the contract requirements, or if obtaining the specified products manufactured, assembled or produced in the United States would increase the cost of this contract for purchase of the product by more than ten percent.

ARTICLE 1.8 - COMMUNICATIONS

A. All notices, requests, instructions, approvals, and claims must be in writing and shall be delivered to the Designer and copied to the Construction Representative for the project except as required by Article 1.12 Disputes and Disagreements, or as otherwise specified by the Owner in writing as stated in Section 012600. Any such notice shall be deemed to have been given as of the time of actual receipt.

B. The Contractor shall attend on-site progress and coordination meetings, as scheduled by the Construction Representative, no less than once a month.

C. The Contractor shall ensure that major subcontractors and suppliers shall attend monthly progress meetings as necessary to coordinate the work, and as specifically requested by the Construction Representative.

ARTICLE 1.9 - SEPARATE CONTRACTS AND COOPERATION

A. The Owner reserves the right to let other contracts in connection with this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work and shall properly connect and coordinate his work with theirs.

B. The Contractor shall consult the drawings for all other contractors in connection with this work. Any work conflicting with the above shall be brought to the attention of the Owner’s Representative before the work is performed. If the Contractor fails to do this, and constructs any work which interferes with the work of another contractor, the Contractor shall remove any part so conflicting and rebuild same, as directed by the Owner’s Representative at no additional cost to the Owner.

C. Each contractor shall be required to coordinate his work with other contractors so as to afford others reasonable opportunity for execution of their work. No contractor shall delay any other contractor by neglecting to perform contract work at the proper time. If any contractor causes delay to another, they shall be liable directly to that contractor for such delay in addition to any liquidated damages which might be due the Owner.

D. Should the Contractor or project associated subcontractors refuse to cooperate with the instructions and reasonable requests of other Contractors or other subcontractors in the overall coordinating of the work, the Owner may take such appropriate action and issue directions, as required, to avoid unnecessary and unwarranted delays.

E. Each Contractor shall be responsible for damage done to Owner's or other Contractor's property by him/her or workers in his employ through their fault or negligence.

F. Should a Contractor sustain any damage through any act or omission of any other Contractor having a contract with the Owner, the Contractor so damaged shall have no claim or cause of action against the Owner for such damage, but shall have a claim or cause of action against the other Contractor to recover any and all damages sustained by reason of the acts or omissions of such Contractor. The phrase "acts or omissions" as used in this section shall be defined to include, but

not be limited to, any unreasonable delay on the part of any such contractors.

ARTICLE 1.10 - ASSIGNMENT OF CONTRACT

A. No assignment by Contractor of any amount or any part of this contract or of the funds to be received there under will be recognized unless such assignment has had the written approval of the Director and the surety has been given due notice of such assignment and has furnished written consent thereto. In addition to the usual recitals in assignment contracts, the following language must be set forth: "It is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor of this contract and to claims or liens for services rendered or materials supplied for the performance of the work called for in said contract in favor of all persons, firms or corporations rendering such services or supplying such materials."

ARTICLE 1.11 - INDEMNIFICATION

A. Contractor agrees to indemnify and save harmless Owner and its respective commissioners, officers, officials, agents, consultants and employees and Designer, their agents, servants and employees, from and against any and all liability for damage arising from injuries to persons or damage to property occasioned by any acts or omissions of Contractor, any subcontractors, agents, servants or employees, including any and all expense, legal or otherwise, which may be incurred by Owner or Designer, its agents, servants or employees, in defense of any claim, action or suit.

B. The obligations of the Contractor under this paragraph shall not extend to the liability of the Designer, his agents or employees, arising out of (1) the preparation or approval of maps, drawings, opinions, reports, surveys, contract changes, design or specifications, or (2) giving of or the failure to give directions or instructions by the Designer, his agents or employees as required by this contract documents provided such giving or failure to give is the primary cause of the injury or damage.

ARTICLE 1.12 - DISPUTES AND DISAGREEMENTS

It is hereby expressly agreed and understood that in case any controversy or difference of opinion arises during construction, best efforts will be given to resolution at the field level. Should those efforts be unsuccessful, the Contractor has the right to appeal in writing, the decision of the Director's Designee to the Director at Room 730 Truman Building, P.O. Box 809, Jefferson City, Missouri 65102. The decision of the Director shall be final and binding on all parties.

ARTICLE 2 -- OWNER/DESIGNER RESPONSIBILITIES

A. The Owner shall give all orders and directions contemplated under this contract relative to the execution of the work. During progress of work the Owner will be represented at the project site by the Construction Representative and/or Designer, whose responsibilities are to see that this contract is properly fulfilled.

B. The Owner shall at all times have access to the work whenever it is in preparation or progress. The Contractors shall provide proper facilities for such access and for inspection and supervision.

C. All materials and workmanship used in the work shall be subject to the inspection of the Designer and Construction Representative, and any work which is deemed defective shall be removed, rebuilt or made good immediately upon notice. The cost of such correction shall be borne by the Contractor. Contractor shall not be entitled to an extension of the contract completion date in order to remedy defective work. All rejected materials shall be immediately removed from the site of the work.

D. If the Contractor fails to proceed at once with the correction of rejected defective materials or workmanship, the Owner may, by separate contract or otherwise, have the defects remedied or rejected. Materials removed from the site and charge the cost of the same against any monies which may be due the Contractor, without prejudice to any other rights or remedies of the Owner.

E. Failure or neglect on the part of Owner to observe faulty work, or work done which is not in accordance with the drawings and specifications shall not relieve the Contractor from responsibility for correcting such work without additional compensation.

F. The Owner shall have the right to direct the Contractor to uncover any completed work.

1. If the Contractor fails to adequately notify the Construction Representative and/or Designer of an inspection as required by the Contract Documents, the Contractor shall, upon written request, uncover the work. The Contractor shall bear all costs associated with uncovering and again covering the work exposed.

2. If the Contractor is directed to uncover work, which was not otherwise required by the Contract Documents to be inspected, and the work is found to be defective in any respect, no compensation shall be allowed for this work. If, however, such work is found to meet

the requirements of this contract, the actual cost of labor and material necessarily involved in the examination and replacement plus 10% shall be allowed the Contractor.

G. The Designer shall give all orders and directions contemplated under this contract relative to the scope of the work and shall give the initial interpretation of the contract documents.

H. The Owner may file a written notice to the Contractor to dismiss immediately any subcontractors, project managers, superintendents, foremen, workers, watchmen or other employees whom the Owner may deem incompetent, careless or a hindrance to proper or timely execution of the work. The Contractor shall comply with such notice as promptly as practicable without detriment to the work or its progress.

I. If in the Owner's judgment it becomes necessary at any time to accelerate work, when ordered by the Owner in writing, the Contractor shall redirect resources to such work items and execute such portions of the work as may be required to complete the work within the current approved contract schedule.

ARTICLE 3 -- CONTRACTOR RESPONSIBILITIES

The Contractor shall register and utilize the Owner's eBuilder digital project management system for submission of documents described in the following sections. This includes but is not limited to submittals as required by designer, payment applications, Request for Information (RFI), construction change orders, Request for Proposals (RFP), Designer Supplemental Instructions (DSI), etc.

ARTICLE 3.1 -- ACCEPTABLE SUBSTITUTIONS

A. The Contractor may request use of any article, device, product, material, fixture, form or type of construction which in the judgment of the Owner and Designer is equal in all respects to that named. Standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner and Designer that they are equal in design, strength, durability, usefulness and convenience for the purpose intended.

B. Any changes required in the details and dimensions indicated on the drawings for the substitution of products other than those specified shall be properly made at the expense of the Contractor requesting the substitution or change.

C. The Contractor shall submit a request for such substitutions in writing to the Owner and Designer within twenty (20) working days after the date of the "Notice to Proceed." Thereafter no consideration will be given to alternate forms of accomplishing the work. This Article does not preclude the Owner from exercising the provisions of Article 4 hereof.

D. Any request for substitution by the Contractor shall be submitted in accordance with SECTION 002113 - INSTRUCTIONS TO BIDDERS.

E. When a material has been approved, no change in brand or make will be permitted unless:

1. Written verification is received from the manufacturer stating they cannot make delivery on the date previously agreed, or
2. Material delivered fails to comply with contract requirements.

ARTICLE 3.2 -- SUBMITTALS

A. The Contractor's submittals must be submitted with such promptness as to allow for review and approval so as not to cause delay in the work. The Contractor shall coordinate preparation and processing of submittals with performance of construction activities.

Coordinate each submittal with fabrication, = purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

Submit four (4) copies to the Designer and additional copies as required for the subcontractors and material suppliers. Also provide copies to meet the requirements for maintenance manuals.

B. All subcontractors' shop drawings and schedules shall be submitted by the Contractor and shall bear evidence that Contractor has received, reviewed, and approved them. Any shop drawings and schedules submitted without this evidence will be returned to the Contractor for resubmission.

C. The Contractor shall include with the shop drawing, a letter indicating any and all deviations from the drawings and/or specifications. Failure to notify the Designer of such deviations will be grounds for subsequent rejection of the related work or materials. If, in the opinion of the Designer, the deviations are not acceptable, the Contractor will be required to furnish the item as specified and indicated on the drawings.

D. The Designer shall check shop drawings and schedules with reasonable promptness and approve them only if they conform to the design concept of the project and comply with the information given in the contract documents. The approval shall not relieve the Contractor from the responsibility to comply with the drawings and specifications, unless the Contractor has called the Designer's attention to the deviation, in writing, at the time of

submission and the Designer has knowingly approved thereof. An approval of any such modification will be given only under the following conditions:

1. It is in the best interest of the Owner
2. It does not increase the contract sum and/or completion time
3. It does not deviate from the design intent
4. It is without prejudice to any and all rights under the surety bond.

E. No extension of time will be granted because of the Contractor's failure to submit shop drawings and schedules in ample time to allow for review, possible resubmission, and approval. Fabrication of work shall not commence until the Contractor has received approval. The Contractor shall furnish prints of approved shop drawings and schedules to all subcontractors whose work is in any way related to the work under this contract. Only prints bearing this approval will be allowed on the site of construction

F. The Contractor shall maintain a complete file on-site of approved shop drawings available for use by the Construction Representative.

ARTICLE 3.3 – AS-BUILT DRAWINGS

A. The Contractor shall update a complete set of the construction drawings, shop drawings and schedules of all work monthly by marking changes, and at the completion of their work (prior to submission of request for final payment) note all changes and turn the set over to the Construction Representative. The updates shall show all addenda, all field changes that were made to adapt to field conditions, changes resulting from contract changes or supplemental instructions, and all locations of structures, buried installations of piping, conduit, and utility services. All buried and concealed items both inside and outside shall be accurately located as to depth and referenced to permanent features such as interior or exterior wall faces and dimensions shall be given in a neat and legible manner in a contrasting colored pencil or ink. If approved by the Designer, an electronic file format may be provided.

ARTICLE 3.4 – GUARANTY AND WARRANTIES

A. General Guaranty

1. Neither the final certificate of payment nor any provision in the contract documents nor partial use or occupancy of the premises by the Owner shall constitute an acceptance of work not done in accordance with contract requirements.
2. The Contractor or surety shall remedy any defects in the work and pay for any damage to property resulting there from which shall appear within a period of one (1) year from the date of substantial completion unless a longer period is otherwise specified or a differing guaranty period has been established in the substantial completion certificate. The Owner will give notice of observed defects with reasonable promptness.
3. In case of default on the part of the Contractor in fulfilling this part of this contract, the Owner may correct the work or repair the damage and the cost and expense incurred in such event shall be paid by or recoverable from the Contractor or surety.
4. The work will be free from defects not inherent in the quality required or permitted, and that the Work will conform to the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's guaranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment

B. Extended Warranty

Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year. Where a longer period is offered at no additional cost or called for in the specific equipment specifications, the longer period shall govern.

ARTICLE 3.5 -- OPERATION AND MAINTENANCE MANUALS

A. Immediately after equipment submittals are approved and no later than ten (10) working days prior to the substantial completion inspection, the Contractor shall provide to the Designer three (3) copies of operating instructions and service manuals, containing the following:

1. Start-up and Shut-down Procedures: Provide a step-by-step write up of all major equipment. When manufacturer’s printed start-up, trouble shooting and shut-down procedures are available; they may be incorporated into the operating manual for reference.

2. Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.

3. Equipment List: List of all major equipment as installed shall be prepared to include model number, capacities, flow rate, name place data, shop drawings and air and water balance reports.

4. Service Instructions: Provide the following information for all pieces of equipment.

   a. Recommended spare parts including catalog number and name of local supplier or factory representative.

   b. Belt sizes, types, and lengths.

   c. Wiring diagrams.

5. Manufacturer's Certificate of Warranty as described in Article 3.4.

6. Prior to the final payment, furnish to the Designer three (4) copies of parts catalogs for each piece of equipment furnished by him/her on the project with the components identified by number for replacement ordering.

B. Submission of operating instructions shall be done in the following manner.

1. Manuals shall be in quadruplicate, and all materials shall be bound into volumes of standard 8½" x 11" hard binders. Large drawings too bulky to be folded into 8½" x 11" shall be separately bound or folded and in envelopes, cross referenced and indexed with the manuals.

2. The manuals shall identify project name, project number, and include the name and address of the Contractor, subcontractors and manufacturers who were involved with the activity described in that particular manual.

3. Internally subdivide the binder contents with permanent page dividers, logically organized with tab titles clearly printed under reinforced laminated plastic tabs.

4. Contents: Prepare a Table of Contents for each volume, with each product or system description identified.

ARTICLE 3.6 – OTHER CONTRACTOR RESPONSIBILITIES

A. The Contractor shall keep on site, during progress of the work, a competent superintendent satisfactory to the Construction Representative. The superintendent shall represent the Contractor and all agreements made by the superintendent shall be binding. The superintendent shall carefully study and compare all drawings, specifications and other instructions and shall promptly notify the Construction Representative and Designer, in writing, any error, inconsistency or omission which may be discovered. The superintendent shall coordinate all work on the project. Any change of the superintendent shall be approved by the Construction Representative.

B. Contractor shall, at all times, enforce strict discipline and good order among his employees, and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him/her.

C. The Contractor shall supply sufficient labor, material, plant and equipment and pay when due any laborer, subcontractor or supplier for supplies furnished and otherwise prosecute the work with diligence to prevent work stoppage and ensure completion thereof within the time specified.

D. The Contractor and each of his subcontractors shall submit to the Construction Representative, through the Designer such schedules of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the Owner may request concerning work performed or to be performed under this contract.

E. The Contractor, subcontractors, and material suppliers shall upon written request, give the Owner access to all time cards, material invoices, payrolls, estimates, profit and loss statements, and all other direct or indirect costs related to this work.

F. The Contractor shall be responsible for laying out all contract work such as layout of architectural, structural, mechanical and electrical work, which shall be coordinated with layouts of subcontractors for general construction work. The Contractor is also responsible for unloading, uncrating and handling of all materials and equipment to be erected or placed by him/her, whether furnished by Contractor or others. No extra charges or compensation will be allowed as a result of failure to verify dimensions before ordering materials or fabricating items.

G. The Contractor must notify the Construction Representative at least one working day before placing concrete or burying underground utilities, pipelines, etc.

H. Contractors shall prearrange time with the Construction Representative for the interruption of any facility operation. Unless otherwise specified in these documents, all connections, alterations or relocations as well as all other portions of the work will be performed during normal working hours.

I. The Contractor shall coordinate all work so there will not be prolonged interruptions of existing equipment operation. Any existing plumbing, heating, ventilating, air conditioning or electrical disconnections necessary for the project, which affect portions of this construction or building or any other building must be scheduled with the Construction Representative to minimize or avoid any disruption of facility operations. In no case, unless previously approved in writing by the Construction Representative, shall utilities be left disconnected at the end of a work day or over a weekend. Any interruption of utilities either intentionally or accidentally shall not relieve the Contractor responsible for the interruption from the responsibility to repair and restore the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.

J. Contractors shall limit operations and storage of materials to the area within the project, except as necessary to connect to existing utilities, and shall not encroach on neighboring property. The Contractor shall be responsible for repair of their damage to property on or off the project site occurring during construction of project. All such repairs shall be made to the satisfaction of the property owner.

K. Unless otherwise permitted, all materials shall be new and both workmanship and materials shall be of the best quality.

L. Unless otherwise provided and stipulated within these specifications, the Contractor shall furnish, construct, and/or install and pay for materials, devices, mechanisms, equipment, all necessary personnel, utilities including, but not limited to water, heat, light and electric power, transportation services, applicable taxes of every nature, and all other facilities necessary for the proper execution and completion of the work.

M. Contractor shall carefully examine the plans and drawings and shall be responsible for the proper fitting of his material, equipment and apparatus into the building.

N. The Contractor or subcontractors shall not overload, or permit others to overload, any part of any structure during the performance of this contract.

O. All temporary shoring, bracing, etc., required for the removal of existing work and/or for the installation of new work shall be included in this contract. The Contractor shall make good, at no cost to the Owner, any damage caused by improper support or failure of shoring in any respect. Each Contractor shall be responsible for shoring required to protect his work or adjacent property and improvements of Owner and shall be responsible for shoring or for giving written notice to adjacent property owners. Shoring shall be removed only after completion of permanent supports.

P. The Contractor shall provide at the proper time such material as is required for support of the work. If openings are required, whether shown on drawings or not, the Contractor shall see that they are properly constructed.

Q. During the performance of work the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences and other devices appropriately located on site which will give proper and understandable warning to all persons of danger of entry onto land, structure or equipment.

R. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials.

S. The Contractor shall be responsible for care of the finished work and shall protect same from damage or defacement until substantial completion by the Owner. If the work is damaged by any cause, the Contractor shall immediately begin to make repairs in accordance with the drawings and specifications. Contractor shall be liable for all damage or loss unless attributable to the acts or omissions of the Owner or Designer. Any claim for reimbursement shall be submitted in accordance with Article 4. After substantial completion the Contractor will only be responsible for damage resulting from acts or omissions of the Contractor or subcontractors through final warranty.

T. In the event the Contractor encounters an unforeseen hazardous material, the Contractor shall immediately stop work in the area affected and report the condition to the Owner and Designer in writing. The Contractor shall not be required, pursuant to Article 4, to perform, any work relating to hazardous materials.

U. In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 4.

V. Before commencing work, Contractors shall confer with the Construction Representative and facility representative and review any facility rules and regulations which may affect the conduct of the work.

W. Project signs will only be erected on major projects and only as described in the specifications. If no sign is specified, none shall be erected.

ARTICLE 3.7 -- SUBCONTRACTS

A. Subcontractor assignments as identified in the bid form shall not be changed without written approval of the Owner. The Owner will not approve changes of a listed subcontractor unless the Contractor documents, to the satisfaction of the Owner that the subcontractor cannot or will not perform the work as specified.

B. The Contractor is fully responsible to the Owner for the acts and omissions of all subcontractors and of persons either directly or indirectly employed by them.

C. Every subcontractor shall be bound by the applicable terms and provisions of these contract documents, but no contractual relationship shall exist between any subcontractor and the Owner unless the right of the Contractor to proceed with the work is suspended or this contract is terminated as herein provided, and the Owner in writing elects to assume the subcontract.

D. The Contractor shall upon receipt of "Notice to Proceed" and prior to submission of the first payment request, notify the Designer and Construction Representative in writing of the names of any subcontractors to be used in addition to those identified in the bid form and all major material suppliers proposed for all parts of the work.

ARTICLE 4 -- CHANGES IN THE WORK

4.1 CHANGES IN THE WORK

A. The Construction Representative, without giving notice to the surety and without invalidating this contract, may order extra work or make changes by altering, adding to or deducting from the work, this contract sum being adjusted accordingly. All such work shall be executed under the conditions of the original contract. A claim for extension of time caused by any change must be adjusted at the time of ordering such change. No future request for time will be considered.

B. Each Contract Change shall include all costs required to perform the work including all labor, material, equipment, overheads and profit, delay, disruptions, or other miscellaneous expenses. No subsequent requests for additional compensation including claims for delay, disruption, or reduced efficiency as a result of each change will be considered. Values from the Schedule of Values will not be binding as a basis for additions to or deductions from the contract price.

C. The amount of any adjustment in this contract price for authorized changes shall be agreed upon before such changes become effective and shall be determined, through submission of a request for proposal, as follows:

1. By an acceptable fixed price proposal from the Contractor. Breakdowns shall include all takeoff sheets of each Contractor and subcontractor. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.

2. By a cost-plus-fixed-fee (time and material) basis with maximum price, total cost not to exceed said maximum. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.

3. By unit prices contained in Contractor's original bid form and incorporated in the construction contract.

D. Overhead and Profit on Contract Changes shall be applied as follows:

1. The overhead and profit charge by the Contractor and all subcontractors shall be considered to include, but is not limited to: incidental job burdens, small truck (under 1 ton) expense, mileage, small hand tools, warranty costs, company benefits and general office overhead. Project supervision including field supervision and job site office expense shall be considered a part of overhead and profit unless a compensable time extension is granted.

2. The percentages for overhead and profit charged on Contract Changes shall be subject to the following limits: (a) the percentage mark-up for the Contractor shall be limited to the Contractor’s fee: (b) fifteen percent (15%) maximum for Work directly performed by employees of a subcontractor, or sub-subcontractor; (c) five percent (5%) maximum for the Work performed or passed through to the Owner by the Contractor; (d) five percent (5%) maximum subcontractor’s mark-up for

Work performed by a sub-subcontractor and passed through to the Owner by the subcontractor and Contractor; and (e) in no case shall the total overhead and profit paid by the Owner on any Contract Changes exceed twenty-five percent (25%) of the cost of materials, labor and equipment (exclusive of Contractor or any Subcontractor overhead and profit) necessary to put the contract change work in place.

3. The Contractor will be allowed to add the cost of Contractor's payment and performance bonding, builder's risk insurance, and general liability insurance to their cost of work. The above listed bonding and insurance cost shall not exceed two percent (2%) and shall be allowed on the total cost of the added work, including overhead and profit.

4. On proposals covering both increases and decreases in the amount of this contract, the application of overhead and profit shall be on the net change in the cost of the work.

5. The percentage(s) for overhead and profit to be credited to the Owner on Contract Changes that are solely decreases in the quantity of work or materials shall be the same as those for additive Contract Changes provided above.

E. No claim for an addition to this contract sum shall be valid unless authorized as aforesaid in writing by the Owner. In the event that none of the foregoing methods are agreed upon, the Owner may order the Contractor to perform work on a time and material basis. The cost of such work shall be determined by the Contractor's actual labor and material cost to perform the work plus overhead and profit as outlined herein. The Designer and Construction Representative shall approve the Contractor's daily time and material invoices for the work involved.

F. If the Contractor claims that any instructions involve extra cost under this contract, the Contractor shall give the Owner's Representative written notice thereof within a reasonable time after the receipt of such instructions, and in any event before proceeding to execute the work. No such claim shall be valid unless so made and authorized by the Owner, in writing.

G. In an emergency affecting the safety of life or of the structure or of adjoining property, the Contractor, without special instruction or authorization from the Construction Representative, is hereby permitted to act at their discretion to prevent such threatened loss or injury. The Contractor shall submit a claim for compensation for such emergency work in writing to the Owner's Representative.

ARTICLE 4.2 – CHANGES IN COMPLETION TIME

A. Extension of the number of work days stipulated in the Contract for completion of the work with compensation may be made when:

1. The contractor documents that proposed Changes in the work, as provided in Article 4.1, extends construction activities critical to contract completion date, OR

2. The Owner suspends all work for convenience of the Owner as provided in Article 7.3, OR

3. An Owner caused delay extends construction activities critical to contract completion (except as provided elsewhere in these General Conditions). The Contractor is to review the work activities yet to begin and evaluate the possibility of rescheduling the work to minimize the overall project delay.

B. Extension of the number of work days stipulated in the Contract for completion of the work <u>without</u> compensation may be made when:

1. Weather-related delays occur, subject to provisions for the inclusion of a specified number of "bad weather" days when provided for in Section 012100-Allowances, OR

2. Labor strikes or acts of God occur, OR

3. The work of the Contractor is delayed on account of conditions which were beyond the control of the Contractor, subcontractors or suppliers, and were not the result of their fault or negligence.

C. No time extension or compensation will be provided for delays caused by or within the control of the Contractor, subcontractors or suppliers and for concurrent delays caused by the Owner.

D. The Contractor shall notify the Owner promptly of any occurrence or conditions which in the Contractor's opinion results in a need for an extension of time. The notice shall be in writing and shall include all necessary supporting materials with details of any resultant costs and be submitted in time to permit full investigation and evaluation of the Contractor's claim. The Owner shall promptly acknowledge the Contractor's notice and, after recommendation from the Owner's Representative and/or Designer, shall provide a decision to the Contractor. Failure on the part of the Contractor to provide such notice and to detail the costs shall constitute a waiver by the Contractor of any claim. Requests for extensions of time shall be for working days only.

ARTICLE 5 - CONSTRUCTION AND COMPLETION

ARTICLE 5.1 – CONSTRUCTION COMMENCEMENT

A. Upon receipt of the "Intent to Award" letter, the Contractor must submit the following properly executed instruments to the Owner:

1. Contract;
2. Performance/payment bond as described in Article 6.1;
3. Certificates of Insurance, or the actual policies themselves, showing that the Contractor has obtained the insurance coverage required by Article 6.2.

Above referenced items must be received by the Owner within ten (10) working days after the effective date of the contract. If not received, the Owner may treat the failure to timely submit them as a refusal by the Contractor to accept a contract for this work and may retain as liquidated damages the Contractor's bid bond, cashier's check or certified check as provided in the Instructions to Bidders. Upon receipt the Owner will issue a "Notice to Proceed" with the work to the Contractor.

B. Within the time frame noted in Section 013200 - Schedules, following receipt of the "Notice to Proceed", the Contractor shall submit to the Owner a progress schedule and schedule of values, showing activities through the end of the contract period. Should the Contractor not receive written notification from the Owner of the disapproval of the schedule of values within fifteen (15) working days, the Contractor may consider it approved for purpose of determining when the first monthly Application and Certification for Payment may be submitted.

C. The Contractor may commence work upon receipt of the Division of Facilities Management, Design and Construction's "Notice to Proceed" letter. Contractor shall prosecute the work with faithfulness and energy, and shall complete the entire work on or before the completion time stated in the contract documents or pay to the Owner the damages resulting from the failure to timely complete the work as set out within Article 5.4.

ARTICLE 5.2 -- PROJECT CONSTRUCTION

A. Each Contractor shall submit for the Owner's approval, in reproducible form, a progress schedule showing the rate of progress and the order of the work proposed to carry on various phases of the project. The schedule shall be in conformance with the requirements outlined in Section 013200 – Schedules.

B. Contractor shall employ and supply a sufficient force of workers, material, and equipment and shall pay when due, any worker, subcontractor or supplier and otherwise prosecute the work with such diligence so as to maintain the rate of progress indicated on the progress schedule, prevent work stoppage, and insure completion of the project within the time specified.

ARTICLE 5.3 -- PROJECT COMPLETION

A. Substantial Completion. A Project is substantially complete when construction is essentially complete and work items remaining to be completed can be done without interfering with the Owner's ability to use the Project for its intended purpose.

1. Once the Contractor has reached what they believe is Substantial Completion, the Contractor shall notify the Designer and the Construction Representative of the following:
   a. That work is essentially complete with the exception of certain listed work items. The list shall be referred to as the "Contractor's Punch."
   b. That all Operation and Maintenance Manuals have been assembled and submitted in accordance with Article 3.5A.
   c. That the Work is ready for inspection by the Designer and Construction Representative. The Owner shall be entitled to a minimum of ten working days notice before the inspection shall be performed.
2. If the work is acceptable, the Owner shall issue a Certificate of Substantial Completion, which shall set forth the responsibilities of the Owner and the Contractor for utilities, security, maintenance, damage to the work and risk of loss. The Certificate shall also identify those remaining items of work to be performed by the Contractor. All such work items shall be complete within 30 working days of the date of the Certificate, unless the Certificate specifies a different time. If the Contractor shall be required to perform tests that must be delayed due to climatic conditions, it is understood that such tests and affected equipment will be identified on the Certificate and shall be accomplished by the Contractor at the earliest possible date. Performance of the tests may not be required before Substantial Completion can be issued. The date of the issuance of the Certificate of

Substantial Completion shall determine whether or not the work was completed within the contract time and whether or not Liquidated Damages are due.

3. If the work is not acceptable, and the Owner does not issue a Certificate of Substantial Completion, the Owner shall be entitled to charge the Contractor with the Designer's and Owner's costs of re-inspection, including time and travel.

B. Partial Occupancy. Contractor agrees that the Owner shall be permitted to occupy and use any completed or partially completed portions of the Project, when such occupancy and use is in the Owner's best interest. Owner shall notify Contractor of its desire and intention to take Partial Occupancy as soon as possible but at least ten (10) working days before the Owner intends to occupy. If the Contractor believes that the portion of the work the Owner intends to occupy is not ready for occupancy, the Contractor shall notify the Owner immediately. The Designer shall inspect the work in accordance with the procedures above. If the Contractor claims increased cost of the project or delay in completion as a result of the occupancy, he shall notify the Owner immediately but in all cases before occupancy occurs.

C. Final Completion. The Project is finally complete when the Certificate of Substantial Completion has been issued and all work items identified therein as incomplete have been completed, and when all administrative items required by the contract have been completed. Final Completion entitles the Contractor to payment of the outstanding balance of the contract amount including all change orders and retainage. Within five (5) working days of the date of the Certificate of Substantial Completion, the Contractor shall identify the cost to complete any outstanding items of work. The Designer shall review the Contractor's estimate and either approve it or provide an independent estimate for all such items. If the Contractor fails to complete the remaining items within the time specified in the Certificate, the Owner may terminate the contract and go to the surety for project completion in accordance with Article 7.2 or release the contract balance to the Contractor less 150% of the approved estimate to complete the outstanding items. Upon completion of the outstanding items, when a final cost has been established, any monies remaining shall be paid to the Contractor. Failure to complete items of work does not relieve the Contractor from the obligation to complete the administrative requirements of the contract, such as the provisions of Article 5.3 FAILURE TO COMPLETE ALL ITEMS OF WORK UNDER THE CONTRACT SHALL BE CONSIDERED A DEFAULT AND BE GROUNDS FOR CONTRACT TERMINATION AND DEBARMENT.

D. Liquidated Damages. Contractor agrees that the Owner may deduct from the contract price and retain as liquidated damages, and not as penalty or forfeiture, the sum stipulated in this contract for each work day after the Contract Completion Day on which work is not Substantially Complete. Assessment of Liquidated Damages shall not relieve the Contractor or the surety of any responsibility or obligation under the Contract. In addition, the Owner may, without prejudice to any other rights, claims, or remedies the Owner may have including the right to Liquidated Damages, charge the Contractor for all additional expenses incurred by the Owner and/or Designer as the result of the extended contract period through Final Completion. Additional Expenses shall include but not be limited to the costs of additional inspections.

E. Early Completion. The Contractor has the right to finish the work before the contract completion date; however, the Owner assumes no liability for any hindrances to the Contractor unless Owner caused delays result in a time extension to the contract completion date. The Contractor shall not be entitled to any claims for lost efficiencies or for delay if a Certificate of Substantial Completion is given on or before the Contract Completion Date.

ARTICLE 5.4 -- PAYMENT TO CONTRACTOR

A. Payments on account of this contract will be made monthly in proportion to the work which has been completed. Request for payment must be submitted on the Owner's forms. No other pay request will be processed. Supporting breakdowns must be in the same format as Owner's forms and must provide the same level of detail. The Designer will, within 5 working days from receipt of the contractor's request for payment either issue a Certificate for Payment to the Owner, for such amount as the Designer determines is properly due, or notify the Contractor in writing of reasons for withholding a Certificate. The Owner shall make payment within 30 calendar days after the "Application and Certification for Payment" has been received and certified by the Designer. The following items are to be attached to the contractor's pay request:

1. Updated construction schedule
2. Certified payrolls consisting of name, home addresses of all workers, occupation and craft, number of hours worked and actual wages paid for each individual employee, of the Contractor and all subcontractors working on the project

B. The Owner shall retain 5 percent of the amount of each such payment application, except as allowed by Article 5.4, until final completion and acceptance of all work covered by this contract.

C. Each payment made to Contractor shall be on account of the total amount payable to Contractor and all material and work covered by paid partial payment shall thereupon become the sole property of Owner. This provision shall not be construed as relieving Contractor from sole responsibility for care and protection of materials and work upon which payments have been made or restoration of any damaged work or as a waiver of the right of Owner to require fulfillment of all terms of this contract.

D. Materials delivered to the work site and not incorporated in the work will be allowed in the Application and Certification for Payment on the basis of one hundred (100%) percent of value, subject to the 5% retainage providing that they are suitably stored on the site or in an approved warehouse in accordance with the following requirements:

1. Material has previously been approved through submittal and acceptance of shop drawings conforming to requirements of Article 3.2 of General Conditions.

2. Delivery is made in accordance with the time frame on the approved schedule.

3. Materials, equipment, etc., are properly stored and protected from damage and deterioration and remain so - if not, previously approved amounts will be deleted from subsequent pay applications.

4. The payment request is accompanied by a breakdown identifying the material equipment, etc. in sufficient detail to establish quantity and value.

E. The Contractor shall be allowed to include in the Application and Certification for Payment, one hundred (100%) of the value, subject to retainage, of major equipment and material stored off the site if all of the following conditions are met:

1. The request for consideration of payment for materials stored off site is made at least 15 working days prior to submittal of the Application for Payment including such material. Only materials inspected will be considered for inclusion on Application for Payment requests.

2. Materials stored in one location off site are valued in excess of $25,000.

3. That a Certificate of Insurance is provided indicating adequate protection from loss, theft conversion or damage for materials stored off site. This Certificate shall show the State of Missouri as an additional insured for this loss.

4. The materials are stored in a facility approved and inspected, by the Construction Representative.

5. Contractor shall be responsible for, Owner costs to inspect out of state facilities, and any delays in the completion of the work caused by damage to the material or for any other failure of the Contractor to have access to this material for the execution of the work.

F. The Owner shall determine the amount, quality and acceptability of the work and materials which are to be paid for under this contract. In the event any questions shall arise between the parties, relative to this contract or specifications, determination or decision of the Owner or the Construction Representative and the Designer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under this contract affected in any manner or to any extent by such question.

G. Payments Withheld: The Owner may withhold or nullify in whole or part any certificate to such extent as may be necessary to protect the Owner from loss on account of:

1. Defective work not remedied. When a notice of noncompliance is issued on an item or items, corrective action shall be undertaken immediately. Until corrective action is completed, no monies will be paid and no additional time will be allowed for the item or items. The cost of corrective action(s) shall be borne by the Contractor.

2. A reasonable doubt that this contract can be completed for the unpaid balance.

3. Failure of the Contractor to update as-built drawings monthly for review by the Construction Representative.

4. Failure of the Contractor to update the construction schedule.

When the Construction Representative is satisfied the Contractor has remedied above deficiencies, payment shall be released.

H. Final Payment: Upon receipt of written notice from the Contractor to the Designer and Project Representative that the work is ready for final inspection and acceptance, the Designer and Project Representative, with the Contractor, shall promptly make such inspection. If the work is acceptable and the contract fully performed, the Construction Representative shall complete a final acceptance report and the Contractor will be

directed to submit a final Application and Certification for Payment. If the Owner approves the same, the entire balance shall be due and payable, with the exception of deductions as provided for under Article 5.4.

1. Where the specifications provide for the performance by the Contractor of (certain tests for the purpose of balancing and checking the air conditioning and heating equipment and the Contractor shall have furnished and installed all such equipment in accordance with the specifications, but said test cannot then be made because of climatic conditions, such test shall may be considered as required under the provisions of the specifications, Section 013300 and this contract may be substantial Full payment will not be made until the tests have been made and the equipment and system is finally accepted. If the tests are not completed when scheduled, the Owner may deduct 150% of the value of the tests from the final payment.
2. The final payment shall not become due until the Contractor delivers to the Construction Representative:

    a) A complete file of releases, on the standard form included in the contract documents as "Final Receipt of Payment and Release Form", from subcontractors and material suppliers evidencing payment in full for services, equipment and materials, as the case may require, if the Owner approves, or a consent from the Surety to final payment accepting liability for any unpaid amounts.

    b) An Affidavit of Compliance with Prevailing Wage Law, in the form as included in this contract specifications, properly executed by each subcontractor, and the Contractor

    c) Certified copies of all payrolls

    d) As-built drawings

3. If any claim remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such a claim including all costs and a reasonable attorney's fee.
4. Missouri statute requires prompt payment from the Owner to the Contractor within thirty calendar days and from the Contractor to his subcontractors within fifteen calendar days. Failure to make payments within the required time frame entitles the receiving party to charge interest at the rate of one and one half percent per month calculated from the expiration of the statutory time period until paid.
5. The value of all unused unit price allowances and/or 150% of the value of the outstanding work items, and/or liquidated damages may be deducted from the final pay request without executing a Contract Change. Any unit price items which exceed the number of units in the contract may be added by Contract Change.

ARTICLE 6 -- INSURANCE AND BONDS

ARTICLE 6.1 -- BOND

A. Contractor shall furnish a performance/payment bond in an amount equal to 100% of the contract price to guarantee faithful performance of the contract and 100% of the contract price to guarantee the payment of all persons performing labor on the project and furnishing materials in connection therewith under this contract as set forth in the standard form of performance and payment bond included in the contract documents. The surety on such bond shall be issued by a surety company authorized by the Missouri Department of Insurance to do business in the state of Missouri.

B. All Performance/Payment Bonds furnished in response to this provision shall be provided by a bonding company with a rating of B+ or higher as established by A.M. Best Company, Inc. in their most recent publication.

ARTICLE 6.2 – INSURANCE

A. The successful Contractor shall procure and maintain for the duration of the contract issued a policy or policies of insurance for the protection of both the Contractor and the Owner and their respective officers, officials, agents, consultants and employees. The Owner requires certification of insurance coverage from the Contractor prior to commencing work.

B. Minimum Scope and Extent of Coverage

1. General Liability

Commercial General Liability, ISO coverage form number or equivalent CG 00 01 ("occurrence" basis), or I-SO coverage form number CG 00 02, or ISO equivalent.

If ISO equivalent or manuscript general liability coverage forms are used, minimum coverage will be as follows: Premises/Operations; Independent Contractors; Products/Completed Operations; personal Injury; Broad Form Property Damage including Completed Operations; Broad Form Contractual Liability Coverage to include Contractor's obligations under Article 1.11 Indemnification and any other Special Hazards required by the work of the contract.

2. Automobile Liability

Business Automobile Liability Insurance, ISO Coverage form number or equivalent CA 00 01 covering automobile liability, code 1 "ANY AUTO".

3. Workers' Compensation and Employer's Liability

Statutory Workers' Compensation Insurance for Missouri and standard Employer's Liability Insurance, or the authorization to self-insure for such liability from the Missouri Division of Workers' Compensation.

4. Builder's Risk or Installation Floater Insurance

Insurance upon the work and all materials, equipment, supplies, temporary structures and similar items which may be incident to the performance of the work and located at or adjacent to the site, against loss or damage from fire and such other casualties as are included in extended coverage in broad "All Risk" form, including coverage for Flood and Earthquake, in an amount not less than the replacement cost of the work or this contact price, whichever is greater, with loss payable to Contractor and Owner as their respective interests may appear.

Contractor shall maintain sufficient insurance to cover the full value of the work and materials as the work progresses, and shall furnish Owner copies of all endorsements. If Builder's Risk Reporting- Form of Endorsement is used, Contractor shall make all reports as required therein so as to keep in force an amount of insurance which will equal the replacement cost of the work, materials, equipment, supplies, temporary structures, and other property covered thereby; and if, as a result of Contractor's failure to make any such report, the amount of insurance so recoverable shall be less than such replacement cost, Contractor's interest in the proceeds of such insurance, if any, shall be subordinated to Owner's interest to the end that Owner may receive full reimbursement for its loss.

C. Minimum Limits of Insurance

1. General Liability

Contractor

$2,000,000	combined single limit per occurrence for bodily injury, personal injury, and property damage
$2,000,000	annual aggregate

2. Automobile Liability

$2,000,000	combined single limit per occurrence for bodily injury and property damage

3. Workers' Compensation and Employers Liability

Workers' Compensation limits as required by applicable State Statutes (generally unlimited) and minimum of $1,000,000 limit per accident for Employer's Liability.

General Liability and Automobile Liability insurance may be arranged under individual policies for the full limits required or by a combination of underlying policies with the balance provided by a form-following Excess or Umbrella Liability policy.

D. Deductibles and Self-Insured Retentions

All deductibles, co-payment clauses, and self-insured retentions must be declared to and approved by the Owner. The Owner reserves the right to request the reduction or elimination of unacceptable deductibles or self-insured retentions, as they would apply to the Owner, and their respective officers, officials, agents, consultants and employees. Alternatively, the Owner may request Contractor to procure a bond guaranteeing

payment of losses and related investigations, claims administration, and defense expenses.

E. Other Insurance Provisions and Requirements

The respective insurance policies and coverage, as specified below, must contain, or be endorsed to contain the following conditions or provisions:

1. General Liability

The Owner, and its respective commissioners, officers, officials, agents, consultants and employees shall be endorsed as additional insured's by ISO form CG 20 26 Additional Insured - Designated Person or Organization. As additional insured's, they shall be covered as to work performed by or on behalf of the Contractor or as to liability which arises out of Contractor's activities or resulting from the performance of services or the delivery of goods called for by the Contract.

Contractor's insurance coverage shall be primary with respect to all additional insured's. Insurance of self-insurance programs maintained by the designated additional -insured's shall be excess of the Contractor's insurance and shall not contribute with it.

Additionally, the Contractor and Contractor's general liability insurer shall agree to waive all rights of subrogation against the Owner and any of their respective officers, officials, agents, consultants or employees for claims, losses, or expenses which arise out of Contractor's activities or result from the performance of services or the delivery of goods called for by the Contract.

Contractor's failure to comply with the terms and conditions of these insurance policies shall not affect or abridge coverage for the Owner, or for any of their officers, officials, agents, consultants or employees.

2. Automobile Insurance

The Owner, and their respective officers, officials, agents, consultants and employees shall be endorsed as additional insured's by ISO form CG 20 26 - Additional Insured Designated Person or Organization. As additional insured's, they shall be covered as to work performed by or on behalf of the Contractor or as to liability which arises out of Contractor's activities or resulting from the performance of services or the delivery of goods called for by the Contract.

Contractor's insurance coverage shall be primary with respect to all additional insured's. Insurance or self-insurance programs maintained by the designated additional insured's shall be in excess of the Contractor's insurance and shall not contribute with it.

Additionally, the Contractor and Contractor's automobile insurer shall agree to waive all rights of subrogation against the Owner and any of their respective officers, officials, agents, consultants or employees for claims, losses, or expenses which arise out of Contractor's activities or result from the performance of services or the delivery of goods called for by the Contract.

Contractor's failure to comply with the terms and conditions of these insurance policies shall not affect or abridge coverage for the Owner or for any of its officers, officials, agents, consultants or employees.

3. Workers' Compensation/Employer's Liability

Contractor's workers' compensation insurance shall be endorsed with NCCI form WC 00 03 01 A - Alternative Employer Endorsement. The Alternative Employer Endorsement shall designate the Owner as "alternate employers."

4. All Coverages

Each insurance policy required by this section of the Contract shall contain a stipulation, endorsed if necessary, that the Owner will receive a minimum of a thirty (30) calendar day advance notice of any policy cancellation. Ten (10) calendar days advance notice is required for policy cancellation due to non-payment of premium.

F. Insurer Qualifications and Acceptability

Insurance required hereunder shall be issued by an A.M. Best, "B+" rated, Class IX insurance company approved to conduct insurance business in the state of Missouri.

G. Verification of Insurance Coverage

Prior to Owner issuing a Notice to Proceed, the Contractor-shall furnish the Owner with Certificate(s) of Insurance and with any applicable original endorsements evidencing the required insurance coverage. The insurance certificates and endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. All certificates and endorsements received by the Owner are subject to review and approval by the Owner. The Owner reserves the right to require certified copies of all required policies at any time. If the scope of this contract will exceed one (1) year - or, if any of Contractor's applicable insurance coverage expires prior to completion of the work or services required under this contract -

the Contractor will provide a renewal or replacement certificate before continuing work or services hereunder. If the Contractor fails to provide documentation of required insurance coverage, the Owner may issue a stop work order and no additional contract completion time and/or compensation shall be granted as a result thereof.

ARTICLE 7 – SUSPENSION OR TERMINATION OF CONTRACT

ARTICLE 7.1 - FOR SITE CONDITIONS

When conditions at the site of the proposed work are considered by the Owner to be unsatisfactory for prosecution of the work, the Contractor may be ordered in writing to suspend the work or any part thereof until reasonable conditions exist. When such suspension is not due to fault or negligence of the Contractor, time allowed for completion of such suspended work will be extended by a period of time equal to that lost due to delay occasioned by ordered suspension. This will be a no cost time extension.

ARTICLE 7.2 - FOR CAUSE

A. Termination or Suspension for Cause:

1. If the Contractor shall file for bankruptcy, or should make a general assignment for the benefit of the creditors, or if a receiver should be appointed on account of insolvency, or if the contractor should persistently or repeatedly refuse or fail to supply enough properly skilled workers or proper materials, or if the contractor should fail to make prompt payment to subcontractors or for material or labor, or persistently disregard laws, ordinances or the instructions of the Owner, or otherwise be guilty of a substantial violation of any provision of this contract, then the Owner may serve notice on the Contractor and the surety setting forth the violations and demanding compliance with this contract. Unless within ten (10) consecutive calendar days after serving such notice, such violations shall cease and satisfactory arrangements for correction be made, the Owner may suspend the Contractor's right to proceed with the work or terminate this contract.

2. In the event the Owner suspends Contractor's right to proceed with the work or terminates the contract, the Owner may demand that the Contractor's surety take over and complete the work on this contract, after the surety submits a written proposal to the Owner and receives written approval and upon the surety's failure or refusal to do so within ten (10) consecutive calendar days after demand therefore, the Owner may take over the work and prosecute the same to completion by bid or negotiated contract, or the Owner may elect to take possession of and utilize in completing the work such materials, supplies, appliances and plant as may be on the site of the work, and all subcontractors, if the Owner elects, shall be bound to perform their contracts.

B. The Contractor and its surety shall be and remain liable to the Owner for any excess cost or damages occasioned to the Owner as a result of the actions above set forth.

C. The Contractor in the event of such suspension or termination shall not be entitled to receive any further payments under this contract until the work is wholly finished. Then if the unpaid balance under this contract shall exceed all expenses of the Owner as certified by the Director, such excess shall be paid to the Contractor; but, if such expenses shall exceed the unpaid balance as certified by the Director, the Contractor and their surety shall be liable for and shall pay the difference and any damages to the Owner.

D. In exercising Owner's right to secure completion of the work under any of the provisions hereof, the Director shall have the right to exercise Owner's sole discretion as to the manner, methods and reasonableness of costs of completing the work.

E. The rights of the Owner to suspend or terminate as herein provided shall be cumulative and not exclusive and shall be in addition to any other remedy provided by law.

F. The Contractor in the event of such suspension or termination may be declared ineligible for Owner contracts for a minimal period of twelve (12) months. Further, no contract will be awarded to any Contractor who lists in their bid form any subcontractor whose prior performance has contributed, as determined by the Owner, to a breach of a contract. In order to be considered for state-awarded contracts after this period, the Contractor/subcontractor will be required to forward acceptance reports to the Owner regarding successful completion of non-state projects during the intervening twelve (12) months from the date of default. No contracts will be awarded to a subcontractor/Contractor until the ability to perform responsibly in the private sector has been proven to the Owner.

ARTICLE 7.3 -- FOR CONVENIENCE

A. The Owner may terminate or suspend the Contract or any portion of the Work without cause at any time, and at the Owner's convenience. Notification of a termination or suspension shall be in writing

and shall be given to the Contractor and their surety. If the Contract is suspended, the notice will contain the anticipated duration of the suspension or the conditions under which work will be permitted to resume. If appropriate, the Contractor will be requested to demobilize and re-mobilize and will be reimbursed time and costs associated with the suspension.

B. Upon receipt of notification, the Contractor shall:

1. Cease operations when directed.

2. Take actions to protect the work and any stored materials.

3. Place no further subcontracts or orders for material, supplies, services or facilities except as may be necessary to complete the portion of the Contract that has not been terminated. No claim for payment of materials or supplies ordered after the termination date shall be considered.

4. Terminate all existing subcontracts, rentals, material, and equipment orders.

5. Settle all outstanding liabilities arising from termination with subcontractors and suppliers.

6. Transfer title and deliver to the Owner, work in progress, completed work, supplies and other material produced or acquire for the work terminated, and completed or partially completed plans, drawings information and other property that, if the Contract had been completed, would be required to be furnished to the Owner.

C. For termination without cause and at the Owner's convenience, in addition to payment for work completed prior to date of termination, the Contractor may be entitled to payment of other documented costs directly associated with the early termination of the contract. Payment for anticipated profit and unapplied overhead will not be allowed.

SECTION 007300 - SUPPLEMENTARY CONDITIONS

1.0 GENERAL:

A. These Supplementary General Conditions clarify, add, delete, or otherwise modify standard terms and conditions of DIVISION 00, BIDDING AND CONTRACTING REQUIREMENTS.

2.0 CONTACTS:

Project Manager:

Shannon Thompson
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, MO 65101
Telephone: 573-257-7137
Email: shannon.thompson@oa.mo.gov

3.0 NOTICE: ALL BID MATERIALS ARE DUE AT THE TIME OF BID SUBMITTAL. THERE IS NO SECOND SUBMITTAL FOR THIS PROJECT.

4.0 FURNISHING CONSTRUCTION DOCUMENTS:

A. The Owner will furnish the Contractor with approximately 5 complete sets of drawings and specifications at no charge.

B. The Owner will furnish the Contractor with approximately 5 sets of explanatory or change drawings at no charge.

C. The Contractor may make copies of the documents as needed with no additional cost to the Owner.

5.0 SAFETY REQUIREMENTS

Contractor and subcontractors at any tier shall comply with RSMo 292.675 and Article 1.3, E, of Section 007213, General Conditions.

Missouri
Division of Labor Standards
WAGE AND HOUR SECTION

MIKE KEHOE, Governor

Annual Wage Order No. 33

Section 014
CALLAWAY COUNTY

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by
Logan Hobbs, Director
Division of Labor Standards

Filed With Secretary of State: **March 10, 2026**

Last Date Objections May Be Filed: **April 9, 2026**

Prepared by Missouri Department of Labor and Industrial Relations

CALLAWAY COUNTY

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	$52.62
Boilermaker	$34.78*
Bricklayer - Stone Mason	$58.08
Carpenter	$56.37
Lather	
Linoleum Layers & Cutter	
Millwright	
Pile Driver	
Cement Mason	$34.78*
Plasterer	
Communication Technician	$63.45
Electrician (Inside Wireman)	$63.67
Electrician (Outside Lineman)	$75.60
Outside - Groundman	
Outside - Groundman Tree Trimmer	
Outside - Lineman Operator	
Outside - Lineman Tree Trimmer	
Elevator Constructor	$34.78*
Glazier	$34.78*
Iron Worker	$76.67
Laborer	$44.22
Laborer - First Semi-Skilled	
Laborer - General	
Laborer - Second Semi-Skilled	
Laborer - Skilled	
Mason	$51.88
Marble Finisher	
Marble Mason	
Terrazzo Finisher	
Terrazzo Worker	
Tile Finisher	
Tile Setter	
Operating Engineer	$76.73
Operating Engineer - Group I	
Operating Engineer - Group II	
Operating Engineer - Group III	
Operating Engineer - Group III - A	
Operating Engineer - Group IV	
Operating Engineer - Group V	
Painter	$34.78*
Plumber	$82.38
Pipe Fitter	
Roofer/WaterProofer	$57.36
Sheet Metal Worker	$58.64
Sprinkler Fitter - Fire Protection	$34.78*
Truck Driver	$34.78*
Truck Control Service Driver	
Truck Driver, Teamsters Group I	
Truck Driver, Teamsters Group II	
Truck Driver, Teamsters Group III	
Truck Driver, Teamsters Group IV	

*** The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.**

****The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in RSMo Section 290.210.**

CALLAWAY COUNTY

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	$67.64
Millwright	
Pile Driver	
Electrician (Outside Lineman)	$34.78*
Outside - Groundman	
Outside - Groundman Tree Trimmer	
Outside - Lineman Operator	
Outside - Lineman Tree Trimmer	
Laborer	$55.41
Laborer - General	
Laborer - Skilled	
Operating Engineer	$71.49
Oiler-Driver	
Operating Engineer - Group I	
Operating Engineer - Group II	
Operating Engineer - Group III	
Operating Engineer - Group IV	
Truck Driver	$34.78*
Truck Control Service Driver	
Truck Driver, Teamsters Group I	
Truck Driver, Teamsters Group II	
Truck Driver, Teamsters Group III	
Truck Driver, Teamsters Group IV	

Use Heavy Construction Rates on Highway and Heavy construction in accordance iwth the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title shown on the Building Construction Rate Sheet.

***The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.**

****The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title.**

OVERTIME
and
HOLIDAYS

OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, **"overtime work"** shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

HOLIDAYS

January first;
The last Monday in May;
July fourth;
The first Monday in September;
November eleventh;
The fourth Thursday in November; and
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

SECTION 011000 – SUMMARY OF WORK

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 WORK COVERED BY CONTRACT DOCUMENTS

A. The Project consists of HVAC improvements for housing units.

1. Project Location: State of Missouri Fulton Reception and Diagnostic Center, Fulton, MO 65251.

2. Owner: State of Missouri, Office of Administration, Division of Facilities Management, Design and Construction, Harry S Truman State Office Building, Post Office Box 809, 301 West High Street, Jefferson City, Missouri 65102.

B. Contract Documents, dated August 28, 2026 were prepared for the Project by Henderson Engineers, 8345 Lenexa Drive, Suite 300, Lenexa KS 66214.

C. The Work consists of HVAC improvements for housing units.

1. The Work includes:

a. Addition of packaged rooftop units to provide cooling/heating to dayrooms in existing housing units.
b. Modifications to electrical systems to accommodate new RTUs.
c. Extension of natural gas service to accommodate new RTUs.
d. Addition of structural supports to accommodate new RTUs.
e. Modifications to ceilings/roofs to accommodate new RTUs.
f. Full replacement of fire alarm systems (including all devices and cabling) in Housing Unit 17 and 18, Buildings A, B, C, D, I, J, L, N, O, P.
g. Alternates:
    1. Secure cell windows shut.
    2. Replace existing Chiller at Housing Unit 8.
    3. Replace existing kitchen make-up air unit.
    4. Replace HVU units at Housing Units 1-7.

D. The Work will be constructed under a single prime contract.

E. <u>NOTE: PHASING INFORMATION</u>. THE CONTRACTOR WILL ONLY BE ALLOWED TO WORK ON HALF OF A HOUSING UNIT (2 WINGS) AT ONE TIME.

1.3 WORK UNDER OTHER CONTRACTS (Not Applicable)

1.4 FUTURE WORK (Not Applicable)

1.5 WORK SEQUENCE

A. The Work will be conducted in a single phase.

1.6 CONTRACTOR USE OF PREMISES

A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises limited only by the Owner's right to perform work or to retain other contractors on portions of the Project.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

1. Owner Occupancy: Allow for Owner occupancy and use by the public.

2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage cause by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period..

1.7 OCCUPANCY REQUIREMENTS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate owner usage. Perform the Work so as not to interfere with the Owner's operations.

B. Partial Owner Occupancy: The Owner reserves the right to occupy and to place and install equipment in completed areas of the building prior to Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. The Designer will prepare a Certificate of Partial Occupancy for each specific portion of the Work to be occupied prior to substantial completion.

2. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, the Owner will operate and maintain mechanical and electrical systems serving occupied portions for the building.

3. Upon occupancy, the Owner will assume responsibility for maintenance and custodial service for occupied portions for the building.

1.8 OWNER-FURNISHED PRODUCTS (Not Applicable)

1.9 MISCELLANEOUS PROVISIONS (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF PRODUCTS ORDERED IN ADVANCE (Not Applicable)

END OF SECTION 011000

SECTION 012100 – ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing allowances.

1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.

B. Types of allowances include the following:

1. Lump-sum allowances.
2. Weather allowances.

C. Related Sections include the following:

1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders for allowances.
2. Division 1 Section "Unit Prices" for procedures for using unit prices.

1.3 WEATHER ALLOWANCE

A. Included within the completion period for this project are a specified number of “bad weather” days (see Schedule of Allowances).

B. The Contractor’s progress schedule shall clearly indicate the bad weather day allowance as an “activity” or “activities”. In the event weather conditions preclude performance of critical work activities for 50% or more of the Contractor’s scheduled workday, that day shall be declared unavailable for work due to weather (a “bad weather” day) and charged against the above allowance. Critical work activities will be determined by review of the Contractor’s current progress schedule.

C. The Contractor’s Representative and the Construction Representative shall agree monthly on the number of “bad weather” days to be charged against the allowance. This determination will be documented in writing and be signed by the Contractor and the Construction Representatives. If there is a failure to agree on all or part of the “bad weather” days for a particular month, that disagreement shall be noted on this written document and signed by each party’s representative. Failure of the Contractor’s representative to sign the “bad weather” day documentation after it is presented, with or without the notes of disagreement, shall constitute agreement with the “bad weather” day determination contained in that document.

D. There will be no modification to the time of contract performance due solely to the failure to deplete the “bad weather” day allowance.

E. Once this allowance is depleted, a no cost Change Order time extension will be executed for “bad weather” days, as defined above, encountered during the remainder of the Project.

1.4 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, Designer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.

B. At Designer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Purchase products and systems selected by Designer from the designated supplier.

1.5 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.6 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.7 ALLOWANCES

A. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials under allowance shall be included as part of the Contract Sum and not part of the allowance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Weather Allowance: Included within the completion period for this Project are five “bad weather” days.

END OF SECTION 012100

SECTION 012200 – UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

B. Quantities of Units to be included in the Base Bid are indicated in Section 004322 – Unit Prices.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Unit Prices.

B. Related Sections include the following:

1. Division 1 Section "Allowances" for procedures for using Unit Prices to adjust quantity allowances.
2. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

A. Unit Price is an amount proposed by bidders, stated on the Bid Form Attachment 004322 a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit Prices include all necessary material plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of Work in-place that involves use of established Unit Prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of Unit Prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each Unit Price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

A. Unit Price No. 1:

1. Description: Replace damaged or wet roof insulation.
2. Unit of Measurement: per square foot.
3. Base Bid Quantity: 0

B. Unit Price No. 2:

1. Description: Replace damaged or wet roof cover boards.
2. Unit of Measurement: per square foot
3. Base Bid Quantity: 0

C. Unit Price No. 3:

1. Description: Secure exterior inmate cell window.
2. Unit of Measurement: (1) each
3. Base Bid Quantity: 0

END OF SECTION 012200

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Bid Form and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing Alternates.

1.3 DEFINITIONS

A. Definition: An alternate is an amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents..

1. The cost for each alternate is the net addition to the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.

B. No additional time will be allowed for alternate work unless the number of work days is so stated on the bid form.

1.4 PROCEDURES

A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate the Alternate Work into the Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

B. Notification: The award of the Contract will indicate whether alternates have been accepted or rejected.

C. Execute accepted alternates under the same conditions as other Work of this Contract.

D. Schedule: A “Schedule of Alternates” is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Secure exterior inmate cell windows closed/shut throughout all housing units where work is being performed as indicated on the drawings.

B. Alternate No. 2: Replace existing air-cooled chiller at Housing Unit 8 (20 House) with new chiller.

C. Alternate No. 3: Replace existing kitchen make-up air unit at Building B with new make-up air unit.

D. Alternate No. 4: Replace existing HVU units at Housing Units 1-7 (Building D & L typical plans) with new HVU units.

END OF SECTION 012300

SECTION 012600 – CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing Contract Modifications.

B. Related Sections include the following:

1. Division 1, Section 012100 "Allowances" for procedural requirements for handling and processing Allowances.
2. Division 1, Section 012200 "Unit Prices" for administrative requirements for using Unit Prices.
3. Division 1, Section 013115 “Project Management Communications” for administrative requirements for communications.
4. Division 0, Section 007213, Article 3.1 "Acceptable Substitutions" for administrative procedures for handling Requests for Substitutions made after Contract award.
5. Division 0, Section 007213, Article 4.0 "Changes in the Work" for Change Order requirements.

1.3 REQUESTS FOR INFORMATION

A. In the event that the Contractor or Subcontractor, at any tier, determines that some portion of the Drawings, Specifications, or other Contract Documents requires clarification or interpretation, the Contractor shall submit a “Request for Information” (RFI) in writing to the Designer. A RFI may only be submitted by the Contractor and shall only be submitted on the RFI forms provided by the Owner. The Contractor shall clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed. In the RFI, the Contractor shall set forth an interpretation or understanding of the requirement along with reasons why such an understanding was reached.

B. Responses to RFI shall be issued within ten (10) working days of receipt of the Request from the Contractor unless the Designer determines that a longer time is necessary to provide an adequate response. If a longer time is determined necessary by the Designer, the Designer will, within five (5) working days of receipt of the request, notify the Contractor of the anticipated response time. If the Contactor submits a RFI on a time sensitive activity on the current project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the Designer to respond to the request provided that the Designer responds within the ten (10) working days set forth above.

C. Responses from the Designer will not change any requirement of the Contract Documents. In the event the Contractor believes that a response to a RFI will cause a change to the requirements of the Contract Document, the Contractor shall give written

notice to the Designer requesting a Change Order for the work. Failure to give such written notice within ten (10) working days, shall waive the Contractor's right to seek additional time or cost under Article 4, "Changes in the Work" of the General Conditions.

1.4 MINOR CHANGES IN THE WORK

A. Designer will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Amount or the Contract Time, on "Designer's Supplemental Instructions" (DSI).

1.5 PROPOSAL REQUESTS

A. The Designer or Owner Representative will issue a detailed description of proposed Changes in the Work that may require adjustment to the Contract Amount or the Contract Time. The proposed Change Description will be issued using the "Request for Proposal" (RFP) form. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by the Designer or Owner Representative are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.

2. Within ten (10) working days after receipt of Proposal Request, submit a proposal for the cost adjustments to the Contract Amount and the Contract Time necessary to execute the Change. The Contractor shall submit his proposal on the appropriate Change Order Detailed Breakdown form. Subcontractors may use the appropriate Change Order Detailed Breakdown form or submit their proposal on their letterhead provided the same level of detail is included. All proposals shall include:

   a. A detailed breakdown of costs per Article 4.1 of the General Conditions.

   b. If requesting additional time per Article 4.2 of the General Conditions, include an updated Contractor's Construction Schedule that indicates the effect of the Change including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

1.6 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, the Designer or Owner Representative will issue a Change Order for signatures of Owner and Contractor on the "Change Order" form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 013100 – COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Projects including, but not limited to, the following:

1. Coordination Drawings.
2. Administrative and supervisory personnel.
3. Project meetings.

B. Each Contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific Contractor.

C. Related Sections include the following:

1. Division 1, Section 013200 "Schedules" for preparing and submitting Contractor's Construction Schedule.
2. Articles 1.8.B and 1.8.C of Section 007213 "General Conditions" for coordinating meetings onsite.
3. Article 5.4.H of Section 007213 "General Conditions" for coordinating Closeout of the Contract.

1.3 COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections, which depend on each other for proper installation, connection, and operation.

B. Coordination: Each Contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other Contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required

maintenance, service, and repair of all components including mechanical and electrical.

C. Prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other Contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Startup and adjustment of systems.
8. Project Closeout activities.

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

B. Key Personnel Names: Within fifteen (15) work days of starting construction operations, submit a list of key personnel assignments including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 PROJECT MEETINGS

A. The Owner’s Construction Representative will schedule a Pre-Construction Meeting prior to beginning of construction. The date, time, and exact place of this meeting will be determined after Contract Award and notification of all interested parties. The

Contractor shall arrange to have the Job Superintendent and all prime Subcontractors present at the meeting. During the Pre-Construction Meeting, the construction procedures and information necessary for submitting payment requests will be discussed and materials distributed along with any other pertinent information.

1. Minutes: Designer will record and distribute meeting minutes.

B. Progress Meetings: The Owner's Construction Representative will conduct Monthly Progress Meetings as stated in Articles 1.8.B and 1.8.C of Section 007213 "General Conditions".

1. Minutes: Designer will record and distribute to Contractor the meeting minutes.

C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of Manufacturers and Fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Designer and Construction Representative of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration including requirements for the following:

   a. Contract Documents

   b. Options

   c. Related RFIs

   d. Related Change Orders

   e. Purchases

   f. Deliveries

   g. Submittals

   h. Review of mockups

   i. Possible conflicts

   j. Compatibility problems

   k. Time schedules

   l. Weather limitations

   m. Manufacturer's written recommendations

   n. Warranty requirements

   o. Compatibility of materials

   p. Acceptability of substrates

   q. Temporary facilities and controls

   r. Space and access limitations

   s. Regulations of authorities having jurisdiction

   t. Testing and inspecting requirements

u. Installation procedures

v. Coordination with other Work

w. Required performance results

x. Protection of adjacent Work

y. Protection of construction and personnel

3. Contractor shall record significant conference discussions, agreements, and disagreements including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

6. Revise paragraph below if Project requires holding progress meetings at different intervals. Insert special intervals such as "every third Tuesday" to suit special circumstances.

7. Project name

8. Name and address of Contractor

9. Name and address of Designer

10. RFI number including RFIs that were dropped and not submitted

11. RFI description

12. Date the RFI was submitted

13. Date Designer's response was received

14. Identification of related DSI or Proposal Request, as appropriate

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013115 - PROJECT MANAGEMENT COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

B. Division 1, Section 013300 - Submittals

C. Division 1, Section 012600 – Contract Modification Procedures

1.2 SUMMARY

A. Project Management Communications: The Contractor shall use the Internet web based project management communications tool, E-Builder® ASP software, and protocols included in that software during this project. The use of project management communications as herein described does not replace or change any contractual responsibilities of the participants.

1. Project management communications is available through E-Builder® as provided by "e-Builder®" in the form and manner required by the Owner.

2. The project communications database is on-line and fully functional. User registration, electronic and computer equipment, and Internet connections are the responsibility of each project participant. The sharing of user accounts is prohibited

B. Support: E-Builder® will provide on-going support through on-line help files.

C. Copyrights and Ownership: Nothing in this specification or the subsequent communications supersedes the parties' obligations and rights for copyright or document ownership as established by the Contract Documents. The use of CAD files, processes or design information distributed in this system is intended only for the project specified herein.

D. Purpose: The intent of using E-Builder® is to improve project work efforts by promoting timely initial communications and responses. Secondly, to reduce the number of paper documents while providing improved record keeping by creation of electronic document files

E. Authorized Users: Access to the web site will be by individuals who are authorized users.

1. Individuals shall complete the E-Builder New Company/User Request Form located at the following web site: . Completed forms shall be emailed to the following email address: .

2. Authorized users will be contacted directly and assigned a temporary user password.

3. Individuals shall be responsible for the proper use of their passwords and access to data as agents of the company in which they are employed.

F. Administrative Users: Administrative users have access and control of user licenses and all posted items. DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE! Improper or abusive language toward any party or repeated posting of items intended to deceive or disrupt the work of the project will not be tolerated and will result in deletion of the offensive items and revocation of user license at the sole discretion of the Administrative User(s).

G. Communications: The use of fax, email and courier communication for this project is discouraged in favor of using E-Builder® to send messages. Communication functions are as follows:

1. Document Integrity and Revisions:

   a. Documents, comments, drawings and other records posted to the system shall remain for the project record. The authorship time and date shall be recorded for each document submitted to the system. Submitting a new document or record with a unique ID, authorship, and time stamp shall be the method used to make modifications or corrections.

   b. The system shall make it easy to identify revised or superseded documents and their predecessors.

   c. Server or Client side software enhancements during the life of the project shall not alter or restrict the content of data published by the system. System upgrades shall not affect access to older documents or software.

2. Document Security:

   a. The system shall provide a method for communication of documents. Documents shall allow security group assignment to respect the contractual parties communication except for Administrative Users. DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!

3. Document Integration:

   a. Documents of various types shall be logically related to one another and discoverable. For example, requests for information, daily field reports, supplemental sketches and photographs shall be capable of reference as related records.

4. Reporting:

   a. The system shall be capable of generating reports for work in progress, and logs for each document type. Summary reports generated by the system shall be available for team members.

5. Notifications and Distribution:

a. Document distribution to project members shall be accomplished both within the extranet system and via email as appropriate. Project document distribution to parties outside of the project communication system shall be accomplished by secure email of outgoing documents and attachments, readable by a standard email client.

6. Required Document Types:

a. RFI, Request for Information.

b. Submittals, including record numbering by drawing and specification section.

c. Transmittals, including record of documents and materials delivered in hard copy.

d. Meeting Minutes.

e. Application for Payments (Draft or Pencil).

f. Review Comments.

g. Field Reports.

h. Construction Photographs.

i. Drawings.

j. Supplemental Sketches.

k. Schedules.

l. Specifications.

m. Request for Proposals

n. Designer's Supplemental Instructions

o. Punch Lists

H. Record Keeping: Except for paper documents, which require original signatures and large format documents (greater than 8½ x 11 inches), all other 8½ x 11 inches documents shall be submitted by transmission in electronic form to the E-Builder® web site by licensed users.

1. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier shall respond to documents received in electronic form on the web site, and consider them as if received in paper document form.

2. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall reply or respond by transmissions in electronic form on the web site to documents actually received in paper document form.

3. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall copy any paper document into electronic form and make same available on the web site.

I. Minimum Equipment and Internet Connection: In addition to other requirements specified in this Section, the Owner and his representatives, the Construction Manager and his representatives, the Architect and his consultants, and the Contractor and his sub-contractors and suppliers at every tier required to have a user license(s) shall be responsible for the following:

1. Providing suitable computer systems for each licensed user at the users normal work location[1] with high-speed Internet access, i.e. DSL, local cable company's Internet connection, or T1 connection.

2. Each of the above referenced computer systems shall have the following minimum system[2] and software requirements:

a. Desktop configuration (Laptop configurations are similar and should be equal to or exceed desktop system.)

1) Operating System: Windows XP or newer

2) Internet Browser: Internet Explorer 6.01SP2+ (Recommend IE7.0+)

3) Minimum Recommend Connection Speed: 256K or above

4) Processor Speed: 1 Gigahertz and above

5) RAM: 512 mb

6) Operating system and software shall be properly licensed.

7) Internet Explorer version 7 (current version is a free distribution for download). This specification is not intended to restrict the host server or client computers provided that industry standard HTTP clients may access the published content.

8) Adobe Acrobat Reader (current version is a free distribution for download).

9) Users should have the standard Microsoft Office Suite (current version must be purchased) or the equivalent.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE.)

END OF SECTION 013115

[1] The normal work location is the place where the user is assigned for more than one-half of his time working on this project.

[2] The minimum system herein will not be sufficient for many tasks and may not be able to process all documents and files stored in the E-Builder® Documents area.

SECTION 013200 – SCHEDULE – BAR CHART

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for a Bar Chart Schedule for the project construction activities, schedule of submittals, and schedule for testing.

PART 2 - PRODUCTS – (Not Applicable)

PART 3 - EXECUTION

3.1 SUBMITTAL PROCEDURES

A. The Contractor shall submit to the Designer, within ten (10) working days following the Notice to Proceed, a Progress Schedule including Schedule of Values showing the rate of progress the Contractor agrees to maintain and the order in which he proposed to carry out the various phases of Work. No payments shall be made to the Contractor until the Progress Schedule has been approved by the Owner.

1. The Schedule of Values must have the following line items included with the value of the item as indicated below:

    a. O&M's (Owner's Manual)

        1) $1,000,000.00 (One million) and under – 2% of the total contract amount

        2) Over $1,000,000.00 (One million) – 1% of the total contract amount

    b. Close Out Documents

        1) $1,000,000.00 (One million) and under – 2% of the total contract amount

        2) Over $1,000,000.00 (One million) – 1% of the total contract amount

    c. General Conditions

        1) No more than 10%

B. The Contractor shall submit an updated Schedule for presentation at each Monthly Progress Meeting. The Schedule shall be updated by the Contractor as necessary to reflect the current Schedule and its relationship to the original Schedule. The updated Schedule shall reflect any changes in the logic, sequence, durations, or completion date. Payments to the Contractor shall be suspended if the Progress Schedule is not adequately updated to reflect actual conditions.

C. The Contractor shall submit Progress Schedules to Subcontractors to permit coordinating their Progress Schedules to the general construction Work. The Contractor shall coordinate preparation and processing of Schedules and reports with performance of other construction activities.

3.2 CONSTRUCTION PROGRESS SCHEDULE – BAR CHART SCHEDULE

A. Bar-Chart Schedule: The Contractor shall prepare a comprehensive, fully developed, horizontal bar chart-type Contractor's Construction Schedule. The Contractor for general construction shall prepare the Construction Schedule for the entire Project. The Schedule shall show the percentage of work to be completed at any time, anticipated monthly payments by Owner, as well as significant dates (such as completion of excavation, concrete foundation work, underground lines, superstructure, rough-ins, enclosure, hanging of fixtures, etc.) which shall serve as check points to determine compliance with the approved Schedule. The Schedule shall also include an activity for the number of "bad" weather days specified in Section 012100 – Allowances.

1. The Contractor shall provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week.

    a. If practical, use the same Schedule of Values breakdown for schedule time bars.

2. The Contractor shall provide a base activity time bar showing duration for each construction activity. Each bar is to indicate start and completion dates for the activity. The Contractor is to place a contrasting bar below each original schedule activity time for indicating actual progress and planned remaining duration for the activity.

3. The Contractor shall prepare the Schedule on a minimal number of separate sheets to readily show the data for the entire construction period.

4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on schedule with other construction activities. Include minor elements involved in the overall sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.

5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other required schedules and reports.

6. Indicate the Intent to Award and the Contract Substantial Completion dates on the schedule.

B. Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:

1. Requirement for Phased completion

2. Work by separate Contractors

3. Work by the Owner

4. Pre-purchased materials

5. Coordination with existing construction

6. Limitations of continued occupancies

7. Un-interruptible services
8. Partial Occupancy prior to Substantial Completion
9. Site restrictions
10. Provisions for future construction
11. Seasonal variations
12. Environmental control

C. Work Stages: Use crosshatched bars to indicate important stages of construction for each major portion of the Work. Such stages include, but are not necessarily limited to, the following:

1. Subcontract awards
2. Submittals
3. Purchases
4. Mockups
5. Fabrication
6. Sample testing
7. Deliveries
8. Installation
9. Testing
10. Adjusting
11. Curing
12. Startup and placement into final use and operation

D. Area Separations: Provide a separate time bar to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.

1. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
    a. Structural completion.
    b. Permanent space enclosure
    c. Completion of mechanical installation
    d. Completion of the electrical portion of the Work
    e. Substantial Completion

3.3 SCHEDULE OF SUBMITTALS

A. Upon acceptance of the Construction Progress Schedule, prepare and submit a complete schedule of submittals. Coordinate the submittal schedule with Section 013300 SUBMITTALS, the approved Construction Progress Schedule, list of subcontracts, Schedule of Values and the list of products.

B. Prepare the schedule in chronological order. Provide the following information

1. Scheduled date for the first submittal
2. Related Section number
3. Submittal category
4. Name of the Subcontractor
5. Description of the part of the Work covered
6. Scheduled date for resubmittal
7. Scheduled date for the Designer's final release or approval

C. Distribution: Following the Designer's response to the initial submittal schedule, print and distribute copies to the Designer, Owner, subcontractors, and other parties required to comply with submittal dates indicated.

1. Post copies in the Project meeting room and temporary field office.
2. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the Work and are no longer involved in construction activities.

D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

3.4 SCHEDULE OF INSPECTIONS AND TESTS

A. Prepare a schedule of inspections, tests, and similar services required by the Contract Documents. Submit the schedule with (15) days of the date established for commencement of the Contract Work. The Contractor is to notify the testing agency at least (5) working days in advance of the required tests unless otherwise specified.

B. Form: This schedule shall be in tabular form and shall include, but not be limited to, the following:

1. Specification Section number
2. Description of the test
3. Identification of applicable standards
4. Identification of test methods
5. Number of tests required
6. Time schedule or time span for tests
7. Entity responsible for performing tests
8. Requirements for taking samples
9. Unique characteristics of each service

C. Distribution: Distribute the schedule to the Owner, Architect, and each party involved in performance of portions of the Work where inspections and tests are required.

END OF SECTION 013200

SECTION 013300 – SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

B. Division 1, Section 013115 “Project Management Communications” for administrative requirements for communications.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submittals required for performance of the Work including the following:

1. Shop Drawings
2. Product Data
3. Samples
4. Quality Assurance Submittals
5. Construction Photographs
6. Operating and Maintenance Manuals
7. Warranties

B. Administrative Submittals: Refer to General and Supplementary Conditions other applicable Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:

1. Construction Progress Schedule including Schedule of Values
2. Performance and Payment Bonds
3. Insurance Certificates
4. Applications for Payment
5. Certified Payroll Reports
6. Partial and Final Receipt of Payment and Release Forms
7. Affidavit – Compliance with Prevailing Wage Law
8. Record Drawings
9. Notifications, Permits, etc.

C. The Contractor is obliged and responsible to check all shop drawings and schedules to assure compliance with contract plans and specifications. The Contractor is responsible for the content of the shop drawings and coordination with other contract work. Shop drawings and schedules shall indicate, in detail, all parts of an Item or Work including erection and setting instructions and integration with the Work of other trades.

D. The Contractor shall at all times make a copy, of all approved submittals, available on site to the Construction Representative.

1.3 SUBMITTAL PROCEDURES

A. The Contractor shall comply with the General and Supplementary Conditions and other applicable sections of the Contract Documents. The Contractor shall submit, with such promptness as to cause no delay in his work or in that of any other contractors, all required submittals indicated in Part 3.1 of this section and elsewhere in the Contract Documents. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.

    a. The Designer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

B. Each drawing and/or series of drawings submitted must be accompanied by a letter of transmittal giving a list of the titles and numbers of the drawings. Each series shall be numbered consecutively for ready reference and each drawing shall be marked with the following information:

1. Date of Submission

2. Name of Project

3. Location

4. Section Number of Specification

5. State Project Number

6. Name of Submitting Contractor

7. Name of Subcontractor

8. Indicate if Item is submitted as specified or as a substitution

1.4 SHOP DRAWINGS

A. Comply with the General Conditions, Article 3.2.

B. The Contractor shall submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

C. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings including the following information:

1. Dimensions

2. Identification of products and materials included by sheet and detail number

3. Compliance with specified standards

4. Notation of coordination requirements

5. Notation of dimensions established by field measurement

6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8½"x11" but no larger than 36"x48".

1.5 PRODUCT DATA

A. The Contractor shall comply with the General Conditions, Article 3.2.

B. The Contractor shall collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information including the following information:

   a. Manufacturer's printed recommendations

   b. Compliance with Trade Association standards

   c. Compliance with recognized Testing Agency standards

   d. Application of Testing Agency labels and seals

   e. Notation of dimensions verified by field measurement

   f. Notation of coordination requirements

2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

1.6 SAMPLES

A. The Contractor shall comply with the General Conditions, Article 3.2.

B. The Contractor shall submit full-size, fully fabricated samples, cured and finished as specified, and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.

1. The Contractor shall mount or display samples in the manner to facilitate review of qualities indicated. Prepare samples to match the Designer's sample including the following:

   a. Specification Section number and reference

   b. Generic description of the Sample

   c. Sample source

   d. Product name or name of the Manufacturer

   e. Compliance with recognized standards

   f. Availability and delivery time

2. The Contractor shall submit samples for review of size, kind, color, pattern, and texture. Submit samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.

a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three (3) multiple units that show approximate limits of the variations.

b. Refer to other Specification Sections for requirements for samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

c. Refer to other Sections for samples to be returned to the Contractor for incorporation in the Work. Such samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of sample submittals.

d. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.

3. Field samples are full-size examples erected onsite to illustrate finishes, coatings, or finish materials and to establish the Project standard.

a. The Contractor shall comply with submittal requirements to the fullest extent possible. The Contractor shall process transmittal forms to provide a record of activity.

1.7 QUALITY ASSURANCE DOCUMENTS

A. The Contractor shall comply with the General Conditions, Article 3.2

B. The Contractor shall submit quality control submittals including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.

C. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the Manufacturer certifying compliance with specified requirements.

1. Signature: Certification shall be signed by an officer of the Manufacturer or other individual authorized to contractually bind the Company.

D. Inspection and Test Reports: The Contractor shall submit the required inspection and test reports from independent testing agencies as specified in this Section and in other Sections of the Contract Documents.

E. Construction Photographs: The Contractor shall submit record construction photographs as specified in this Section and in other Sections of the Contract Documents.

1. The Contractor shall submit digital photographs. The Construction Administrator shall determine the quantity and naming convention at the preconstruction meeting.

2. The Contractor shall identify each photograph with project name, location, number, date, time, and orientation.

3. The Contractor shall submit progress photographs monthly unless specified otherwise. Photographs shall be taken one (1) week prior to submitting.

4. The Contractor shall take four (4) site photographs from differing directions and a minimum of five (5) interior photographs indicating the relative progress of the Work.

1.8 OPERATING AND MAINTENANCE MANUALS AND WARRANTIES

A. The Contractor shall submit all required manufacturer's operating instructions, maintenance/service manuals, and warranties in accordance with the General Conditions, Article 3.5, and Supplementary Conditions along with this and other Sections of the Contract Documents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 REQUIRED SUBMITTALS

A. Contractor shall submit the following information for materials and equipment to be provided under this contract.

SPEC SECTION	TITLE	CATEGORY
013200	Schedules	Construction Schedule
013200	Schedules	Schedule of Values
013200	Schedules	List of Subcontractors
013200	Schedules	Major Material Suppliers
017900	Demonstration and Training	Operation / Maintenance Manual
040120.63	Brick Masonry Repair	Product Data
040120.63	Brick Masonry Repair	Sample
042010	Reinforced Unit Masonry	Product Data
042010	Reinforced Unit Masonry	Shop Drawings
042010	Reinforced Unit Masonry	Test Report
051200	Structural Steel Framing	Product Data
051200	Structural Steel Framing	Shop Drawings
051200	Structural Steel Framing	Certification
051200	Structural Steel Framing	Test Report
055000	Metal Fabrications	Product Data
055000	Metal Fabrications	Shop Drawings
055000	Metal Fabrications	Certification
061000	Rough Carpentry	Product Data
061000	Rough Carpentry	Warranty
061000	Rough Carpentry	Certification
070150.19	Preparation for Reroofing	Test Report
070150.19	Preparation for Reroofing	Warranty
072100	Thermal Insulation	Product Data
072100	Thermal Insulation	Test Report
072726	Air and Vapor Barrier	Product Data
072726	Air and Vapor Barrier	Shop Drawings
072726	Air and Vapor Barrier	Certification
072726	Air and Vapor Barrier	Sample
072726	Air and Vapor Barrier	Warranty

075216	Hybrid Modified Bitumen Memebrane Roof	Product Data
075216	Hybrid Modified Bitumen Memebrane Roof	Shop Drawings
075216	Hybrid Modified Bitumen Memebrane Roof	Certification
075216	Hybrid Modified Bitumen Memebrane Roof	Warranty
075423	Thermoplastic-Polyolefin (TPO) Roofing	Product Data
075423	Thermoplastic-Polyolefin (TPO) Roofing	Shop Drawings
075423	Thermoplastic-Polyolefin (TPO) Roofing	Sample
075423	Thermoplastic-Polyolefin (TPO) Roofing	Warranty
076200	Sheet Metal Flashing and Trim	Product Data
076200	Sheet Metal Flashing and Trim	Shop Drawings
076200	Sheet Metal Flashing and Trim	Certification
076200	Sheet Metal Flashing and Trim	Test Report
076200	Sheet Metal Flashing and Trim	Warranty
076200	Sheet Metal Flashing and Trim	Operation / Maintenance Manual
079200	Joint Sealants	Product Data
079200	Joint Sealants	Sample
079200	Joint Sealants	Mock up
079216	Pick-Proof Joint Sealants	Product Data
079216	Pick-Proof Joint Sealants	Sample
079216	Pick-Proof Joint Sealants	Certification
092216	Non-Structural Metal Framing	Product Data
092216	Non-Structural Metal Framing	Test Report
092900	Gypsum Board	Product Data
099123	Painting	Product Data
099123	Painting	Sample
099123	Painting	Mock up
099656	Interior Epoxy Coatings	Product Data
099656	Interior Epoxy Coatings	Certification
099656	Interior Epoxy Coatings	Sample
099656	Interior Epoxy Coatings	Mock up
200548	Seismic Controls for MEPFTR Systems	Test Report
200548	Seismic Controls for MEPFTR Systems	Product Data
200548	Seismic Controls for MEPFTR Systems	Shop Drawings
200548	Seismic Controls for MEPFTR Systems	Certification
220500	Common Work Results for Plumbing	Product Data
220500	Common Work Results for Plumbing	Certification
220515	Basic Piping Material and Methods	Product Data
220515	Basic Piping Material and Methods	Certification
220516	Expansion Fittings and Loops for Plumbing Equipment	Product Data
220529	Hangers and Supports for Plumbing Piping	Product Data
220548	Seismic Controls for Plumbing Systems	Product Data
220523	Identification for Plumbing Piping & Equip-ment	Product Data

227000	Natural Gas Systems	Product Data
227000	Natural Gas Systems	Certification
227000	Natural Gas Systems	Operation / Maintenance Manual
227000	Natural Gas Systems	Test Report
230500	Common Work Results for HVAC	Product Data
230513	Common Motor Requirements for HVAC Equipment	Warranty
220548	Siesmic Controls for Mechanical Systems	Product Data
230550	Vibration Isolation for HVAC	Product Data
230550	Vibration Isolation for HVAC	Test Report
230553	Identification for HVAC Piping and Equip-ment	Product Data
230593	Testing, Adjusting and Balancing for HVAC	Certification
230593	Testing, Adjusting and Balancing for HVAC	Test Report
230700	HVAC Insulation	Product Data
230913	Instrumentation & Control Devices for HVAC	Product Data
230913	Instrumentation & Control Devices for HVAC	Shop Drawings
230913	Instrumentation & Control Devices for HVAC	Operation / Maintenance Manual
230913	Instrumentation & Control Devices for HVAC	Warranty
230923	Direct Digital Control	Product Data
230923	Direct Digital Control	Shop Drawings
230923	Direct Digital Control	Test Report
230923	Direct Digital Control	Operation / Maintenance Manual
230923	Direct Digital Control	Warranty
232113	Hydronic Piping	Product Data
232113.13	Mechanically Joined Hydronic Piping Systems	Product Data
232113.13	Mechanically Joined Hydronic Piping Systems	Operation / Maintenance Manual
232113.13	Mechanically Joined Hydronic Piping Systems	Certification
232114	Hydronic Specialties	Product Data
233113	Metal Ducts	Product Data
233113	Metal Ducts	Test Report
233113	Metal Ducts	Certification
233113	Metal Ducts	Shop Drawings
233300	Air Duct Accessories	Product Data
233300	Air Duct Accessories	Shop Drawings
233300	Air Duct Accessories	Operation / Maintenance Manual
233713	Diffusers, Registers and Grilles	Product Data
233713	Diffusers, Registers and Grilles	Operation / Maintenance Manual
237377	Indirect-Fired Heating & Ventilating Units	Product Data
237377	Indirect-Fired Heating & Ventilating Units	Operation / Maintenance Manual
237377	Indirect-Fired Heating & Ventilating Units	Warranty
237377	Indirect-Fired Heating & Ventilating Units	Test Report
237413	Outdoor Packaged Heating and Cooling Units	Product Data
237413	Outdoor Packaged Heating and Cooling Units	Operation / Maintenance Manual

237413	Outdoor Packaged Heating and Cooling Units	Warranty
237413	Outdoor Packaged Heating and Cooling Units	Test Report
260500	Common Work Results for Electrical	Product Data
260502	Equipment Wiring Systems	Product Data
260502	Equipment Wiring Systems	Shop Drawings
260519	Low-Voltage Elec Power Cond and Cables	Product Data
260519	Low-Voltage Elec Power Cond and Cables	Test Report
260519	Low-Voltage Elec Power Cond and Cables	As-Builts
260519	Low-Voltage Elec Power Cond and Cables	Operation / Maintenance Manual
260526	Grounding and Bonding for Electrical Systems	Product Data
260526	Grounding and Bonding for Electrical Systems	Test Report
260526	Grounding and Bonding for Electrical Systems	As-Builts
260529	Hangers and Supports for Electrical Systems	Product Data
260533	Raceway and Boxes for Electrical Systems	Product Data
260533	Raceway and Boxes for Electrical Systems	As-Builts
260543	Underground Raceways for Electrical Systems	Product Data
260543	Underground Raceways for Electrical Systems	As-Builts
260548	Seismic Controls for Electrical Systems	Product Data
260553	Identification for Electrical Systems	Product Data
260573	Power System Studies	Product Data
260573	Power System Studies	As-Builts
260573	Power System Studies	Sample
260573	Power System Studies	Certification
260573	Power System Studies	Operation / Maintenance Manual
261200	Medium Voltage Transformers	Product Data
261200	Medium Voltage Transformers	Shop Drawings
261200	Medium Voltage Transformers	Test Report
261200	Medium Voltage Transformers	Operation / Maintenance Manual
261200	Medium Voltage Transformers	Warranty
262416	Panelboards	Product Data
262416	Panelboards	Shop Drawings
262416	Panelboards	Test Report
262416	Panelboards	Operation / Maintenance Manual
262416	Panelboards	Warranty
262726	Wiring Devices	Product Data
262726	Wiring Devices	Test Report
262726	Wiring Devices	Warranty
262813	Fuses	Product Data
262813	Fuses	Operation / Maintenance Manual
262816	Enclosed Switches	Product Data
262816	Enclosed Switches	Shop Drawings
262816	Enclosed Switches	Test Report
262816	Enclosed Switches	Operation / Maintenance Manual
262816	Enclosed Switches	Warranty

264313	Surge Protective Devices	Product Data
264313	Surge Protective Devices	Test Report
264313	Surge Protective Devices	Warranty
264313	Surge Protective Devices	Operation / Maintenance Manual
264313	Surge Protective Devices	As-Builts
284600	Fire Detection and Alarm	Test Report
284600	Fire Detection and Alarm	Shop Drawings
284600	Fire Detection and Alarm	Product Data
284600	Fire Detection and Alarm	Operation / Maintenance Manual
284600	Fire Detection and Alarm	Warranty

END OF SECTION 013300

SECTION 013513.16 - SITE SECURITY AND HEALTH REQUIREMENTS (DOC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

1.2 SUBMITTALS

A. List of required submittals:

1. Materials Safety Data Sheets for all hazardous materials to be brought onsite.
2. Schedule of proposed shutdowns, if applicable.
3. Revise list to include all required submittals.
4. A list of the names of all employees who will submit fingerprints for a background check, and the signed privacy documents identified below for each employee.
5. Tuberculin skin test results for all employees required to be tested as set forth below.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ACCESS TO THE SITE

A. The Contractor shall arrange with Facility Representatives to establish procedures for the controlled entry of workers and materials into the work areas at the Facility.

B. The Contractor shall establish regular working hours with Facility Representatives. The Contractor must report changes in working hours or overtime to Facility Representatives and obtain approval twenty-four (24) hours ahead of time. The Contractor shall report emergency overtime to Facility Representatives as soon as it is evident that overtime is needed. The Contractor must obtain approval from Facility Representatives for all work performed after dark.

C. The Contractor shall provide the name and phone number of the Contractor’s employee or agent who is in charge onsite; this individual must be able to be contacted in case of emergency. The Contractor must be able to furnish names and address of all employees upon request.

D. The Contractor shall provide Facility Representatives notice twenty-four (24) hours prior to any possible vehicle entry and/or required escort. The Contractor shall maintain a time log of any delays in gaining entrance to the Facility due to lack of an escort, which is to be submitted monthly with the Contractor’s pay request materials. The purpose of this log is to establish a basis for a contract change, if required. The log shall contain the date and time of delay, date and time of request of entry, workers delayed (name and occupation), and name of the Facility Representative to whom the request was made, if possible. Any delay in entry must be validated by sallyport and pass office personnel at the Facility. Only delays greater than thirty (30) minutes will be considered for a contract change. A 30-minute delay upon arrival with a vehicle to enter the sallyport should be expected.

3.2 RULES OF THE FACILITY

A. The Contractor and its workers shall observe the following rules:

1. There shall be no fraternization with inmates.
2. No intoxicating beverages or illegal drugs shall be brought onto Facility grounds.
3. No firearms, other weapons, or explosives shall be carried onto Facility grounds.
4. No prescription drugs above one day's dosage shall be carried on Facility grounds.
5. Any vehicle or individual is subject to search at any time while on Facility grounds.
6. The vehicles of the Contractor and its workers shall be locked whenever unattended.
7. All tools and equipment shall be tightly secured during non-working hours in the Contractor's storage trailer or assigned area.
8. The Facility will not be responsible for the Contractor's tools, equipment, or materials. The Contractor shall keep and maintain a current tool inventory. The tool inventory shall be made available to Facility Representatives and the Owner upon request.
9. The Contractor shall report any missing tools to Facility Representatives immediately.
10. Smoking shall be permitted only in accordance with the regulations of the Facility.
11. Possession or use of smokeless tobacco or smokeless non-tobacco alternatives is strictly prohibited.

B. All workers shall be required to sign an acknowledgement of receipt of these rules.

3.3 SECURITY CLEARANCES AND RESTRICTIONS

A. DOC SECURITY CLEARANCE REQUIREMENTS

1. Prior to the commencement of any onsite work, the Contractor shall submit a list containing the name, date of birth, and Missouri driver's license number or social security number of all construction personnel to the Missouri Department of Corrections for the purpose of obtaining security clearances. The required information shall be submitted at the pre-construction meeting, or as otherwise directed by Department of Corrections' personnel. Any construction personnel with pending warrants or felony convictions within the last five (5) years or other offenses deemed to create a security risk by Department of Corrections shall not be allowed onsite. The Department of Corrections reserves the right to refuse admission to any individual they feel may be detrimental to the security of the Facility.

3.4 FIRE PROTECTION, SAFETY, AND HEALTH CONTROLS

A. The Contractor shall take all necessary precautions to guard against and eliminate possible fire hazards.

1. Onsite burning is prohibited.
2. The Contractor shall store all flammable or hazardous materials in proper containers located outside the buildings or offsite, if possible.
3. The Contractor shall provide and maintain, in good order, during construction fire extinguishers as required by the National Fire Protection Association. In areas of flammable liquids, asphalt, or electrical hazards, 15-pound carbon dioxide or 20-pound dry chemical extinguishers shall be provided.

B. The Contractor shall not obstruct streets or walks without permission from the Owner's Construction Representative and Facility Representatives.

C. The Contractor's personnel shall not exceed the speed limit of 15 mph while at the Facility unless otherwise posted.

D. The Contractor shall take all necessary, reasonable measures to reduce air and water pollution by any material or equipment used during construction. The Contractor shall keep volatile wastes in covered containers, and shall not dispose of volatile wastes or oils in storm or sanitary drains.

E. The Contractor shall keep the project site neat, orderly, and in a safe condition at all times. The Contractor shall immediately remove all hazardous waste, and shall not allow rubbish to accumulate. The Contractor shall provide onsite containers for collection of rubbish and shall dispose of it at frequent intervals during the progress of the Work.

F. Fire exits, alarm systems, and sprinkler systems shall remain fully operational at all times, unless written approval is received from the Owner's Construction Representative and the appropriate Facility Representative at least twenty-four (24) hours in advance. The Contractor shall submit a written time schedule for any proposed shutdowns.

G. For all hazardous materials brought onsite, Material Safety Data Sheets shall be on site and readily available upon request at least a day before delivery.

H. The Contractor's workers shall not be under the influence of any intoxicating substances while on the Facility premises.

3.5 TUBERCULOSIS TESTING REQUIREMENTS

A. All workers who will be in the confines of the Facility for more than ten (10) consecutive working days must provide proof of a negative tuberculin skin test. The test results must be no more than six (6) months old at the commencement of construction. The Contractor or the worker, not the Owner, shall pay the cost of the test.

B. The Contractor shall submit to Facility Representatives current tuberculin skin test results for all workers who are required to have such a test in accordance with paragraph A above. If the contract period extends for more than twelve (12) months, the Contractor must provide new test results for all workers prior to the anniversary of the contract commencement date.

C. Any worker required to have a tuberculin skin test under paragraph A above who fails or refuses to do so will be denied admission to the facility until such time as proof of the test results are provided.

D. If any worker has a tuberculin skin test with positive results, the worker shall be denied access to the facility until the worker produces a certification from a physician licensed to practice in the State of Missouri that the worker does not have infectious tuberculosis.

E. The Contractor shall not be entitled to any additional time or compensation if any of its workers are denied access to the facility because of failure to produce negative tuberculin skin test results.

F. Failure or refusal of the Contractor to maintain and produce the required tuberculin skin test records shall be a material breach of this contract, which shall subject the Contractor to a declaration of default.

3.6 PREA FOR CONTRACTORS AND EMPLOYEES

A. The contractor and all of the contractor's employees and agents providing services in any Department of Corrections institution must be at least 18 years of age. A Missouri Uniform Law Enforcement System (MULES) check or other background investigation may be required on the contractor, the contractor's employees and agents before they are allowed entry into the institution. The contractor, its employees and agents understand and agree that the Department may complete criminal background records checks annually for the contractor and the contractor's employees and agents that have the potential to have contact with inmates.

B. The institution shall have the right to deny access into the institution for the contractor and any of the contractor's employees and agents for any reason, at the discretion of the institution.

C. The contractor, its employees and agents under active federal or state felony or misdemeanor supervision must receive written division director approval prior to providing services pursuant to a Department contract. Similarly, contractors/employees/agents with prior felony convictions and not under active supervision must receive written division director approval in advance.

D. The contractor, its employees and agents shall at all times observe and comply with all applicable state statutes, Department rules, regulations, guidelines, internal management policies and procedures, and general orders of the Department that are applicable, regarding operations and activities in and about all Department property. Furthermore, the contractor, its employees and agents, shall not obstruct the Department or any of its designated officials from performing their duties in response to court orders or in the maintenance of a secure and safe correctional environment. The contractor shall comply with the Department's policies and procedures relating to employee conduct.

1. The Department has a zero tolerance policy for any form of sexual misconduct to include staff/contractor/volunteer on offender, or offender on offender, sexual harassment, sexual assault, sexual abuse and consensual sex.

    a. Any contractor or contractor's employee or agent who witnesses any form of sexual misconduct must immediately report it to the warden of the institution. If a contractor or contractor's employee or agent fails to report or knowingly condones sexual harassment or sexual contact with or between offenders, the Department may cancel the contract, or at the Department's sole discretion, require the contractor to remove the employee/agent from providing services under the contract.
    b. Any contractor or contractor's employee or agent who engages in sexual abuse shall be prohibited from entering the institution and shall be reported to law enforcement agencies and licensing bodies, as appropriate.

E. The contractor, its employees and agents shall not interact with the offenders except as is necessary to perform the requirements of the contract. The contractor, its employees and agents shall not give anything to nor accept anything from the offenders except in the normal performance of the contract.

F. If any contractor or contractor's employee or agent is denied access into the institution for any reason or is denied approval to provide service to the Department for any reason stated herein, it shall not relieve the contractor of any requirements of the contract. If the contractor is unable to perform the requirements of the contract for any reason, the contractor shall be considered in breach.

3.7 DISRUPTION OF UTILITIES

A. The Contractor shall give a minimum of seventy-two (72) hours written notice to the Construction Representative and the Facility Representative before disconnecting electric, gas, water, fire protection, or sewer service to any building.

B. The Contractor shall give a minimum of seventy-two (72) hours written notice to the Construction Representative and Facility Representative before closing any access drives, and shall make temporary access available, if possible. The Contractor shall not obstruct streets, walks, or parking

3.8 CELL PHONES AND ELECTRONIC DEVICES

A. Cell Phones, pagers, smart watches (that can send/receive messages), fitness wrist bands (that can send/receive messages) or other electronic devices are not permitted.

1. Contractors, repairpersons, or information technology services department staff may be permitted to bring in a cell phone and portable wireless router (Wi-Fi, MiFi, etc.) if approved by the Chief Administrative Officer (CAO) when the phone is necessary to complete job duties relating to repairs on a case by case basis.
2. Tables (IPad, etc.) are not allowed with the exception of for re-entry purposes approved via the division of adult institutions (DAI) director and the re-entry manager.
3. Laptop computers may be permitted by the CAO on a case by case basis.

3.9 PROTECTION OF PERSONS AND PROPERTY

A. SAFETY PRECAUTIONS AND PROGRAMS

1. The Contractor shall at all times conduct operations under this Contract in a manner to avoid the risk of bodily harm to persons or risk of damage to any property. The Contractor shall promptly take precautions which are necessary and adequate against conditions created during the progress of the Contractor's activities hereunder which involve a risk of bodily harm to persons or a risk of damage to property. The Contractor shall continuously inspect Work, materials, and equipment to discover and determine any such conditions and shall be solely responsible for discovery, determination, and correction of any such conditions. The Contractor shall comply with applicable safety laws, standards, codes, and regulations in the jurisdiction where the Work is being performed, specifically, but without limiting the generality of the foregoing, with rules regulations, and standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970 and applicable amendments.
2. All contractors, subcontractors and workers on this project are subject to the Construction Safety Training provisions 292.675 RSMo.
3. In the event the Contractor encounters on the site, material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, mercury, or other material known to be hazardous, which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner's Representative and the Architect in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner's Representative and Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless by written agreement of the Owner's Representative and the Contractor. “Rendered Harmless” shall mean that levels

of such materials are less than any applicable exposure standards, including but limited to OSHA regulations.

B. SAFETY OF PERSONS AND PROPERTY

1. The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:

   a. clients, staff, the public, construction personnel, and other persons who may be affected thereby;
   b. the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and
   c. other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

2. The Contractor shall give notices and comply with applicable laws, standards, codes, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.
3. The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.
4. When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.
5. The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in this Section caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under this Section, except damage or loss attributable solely to acts or omissions of Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's other obligations stated elsewhere in the Contract.
6. The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner's Representative and Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment and enforce the use of such equipment by its employees and its subcontractors of any tier.
7. The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.
8. The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately.

9. The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the work, either by or against the Contractor.
10. The Owner assumes no responsibility or liability for the physical condition or safety of the Work site or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.
11. In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.
12. The Contractor shall maintain at his own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for clients, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

END OF SECTION 013513.16

SECTION 015000 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for construction facilities and temporary controls including temporary utilities, support facilities, security, and protection.

B. Temporary utilities include, but are not limited to, the following:

1. Water service and distribution
2. Temporary electric power and light
3. Temporary heat
4. Ventilation
5. Telephone service
6. Sanitary facilities, including drinking water
7. Storm and sanitary sewer

C. Support facilities include, but are not limited to, the following:

1. Field offices and storage sheds
2. Temporary roads and paving
3. Dewatering facilities and drains
4. Temporary enclosures
5. Hoists and temporary elevator use
6. Temporary project identification signs and bulletin boards
7. Waste disposal services **(SEE SECTION FOR INFORMATION)**
8. Rodent and pest control
9. Construction aids and miscellaneous services and facilities

D. Security and protection facilities include, but are not limited to, to following:

1. Temporary fire protection
2. Barricades, warning signs, and lights
3. Sidewalk bridge or enclosure fence for the site
4. Environmental protection

1.3 SUBMITTALS

A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Implementation and Termination Schedule: Within (15) days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations including, but not limited to, the following:

1. Building code requirements
2. Health and safety regulations
3. Utility company regulations
4. Police, fire department, and rescue squad rules
5. Environmental protection regulations

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations". ANSI A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities".

1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code".

C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to the Owner, change over from use of temporary service to use of permanent service.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist onsite.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. If acceptable to the Designer, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

B. Lumber and Plywood: Comply with requirements in Division 6 Section "Rough Carpentry".

1. For job-built temporary office, shops, and sheds within the construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.

2. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sized and thicknesses indicated.

3. For fences and vision barriers, provide minimum 3/9" (9.5mm) thick exterior plywood.

4. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8" (16mm) thick exterior plywood.

C. Gypsum Wallboard: Provide gypsum wallboard on interior walls of temporary offices.

D. Roofing Materials: Provide UL Class A standard-weight asphalt shingles or UL Class C mineral-surfaced roll roofing on roofs of job-built temporary office, shops, and shed.

E. Paint: Comply with requirements of Division 9 Section "Painting".

1. For job-built temporary offices, shops, sheds, fences, and other exposed lumber and plywood, provide exterior-grade acrylic-latex emulsion over exterior primer.

2. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.

3. For interior walls of temporary offices, provide two (2) quarts interior latex-flat wall paint.

F. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of (15) or less. For temporary enclosures, provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

G. Water: Provide potable water approved by local health authorities.

H. Open-Mesh Fencing: Provide 0.120" (3mm) thick, galvanized 2" (50mm) chainlink fabric fencing 6' (2m) high with galvanized steel pipe posts, 1½" (38mm) ID for line posts and 2½" (64mm) ID for corner posts.

2.2 EQUIPMENT

A. General: Provide new equipment. If acceptable to the Designer, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.

B. Water Hoses: Provide ¾" (19mm), heavy-duty, abrasion-resistant, flexible rubber hoses 100' (30m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110 to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage rating.

E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixture where exposed to moisture.

F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.

G. Temporary Offices: Provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.

H. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated re-circulation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers, or a combination of extinguishers of NFPA-recommended classes for the exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each Facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with company recommendations.

1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.

2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.

3. Obtain easements to bring temporary utilities to the site where the Owner’s easements cannot be used for that purpose.

4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Designer. Neither the Owner nor Designer will accept cost or use charges as a basis of claims for Change Order.

B. Temporary Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

1. Sterilization: Sterilize temporary water piping prior to use.

C. Temporary Water Service: The Owner will provide water for construction purposes from the existing building system. All required temporary extensions shall be provided and removed by the Contractor. Connection points and methods of connection shall be designated and approved by the Construction Representative.

D. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.

1. Install electric power service underground, except where overhead service must be used.

2. Power Distribution System: Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125V, AC 20ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.

E. Temporary Electric Power Service: The Owner will provide electric power for construction lighting and power tools. Contractors using such services shall pay all costs of temporary services, circuits, outlet, extensions, etc.

F. Temporary Lighting: When overhead floor or roof deck has been installed, provide temporary lighting with local switching.

1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.

G. Temporary Heating: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

1. Heating Facilities: Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP gas or fuel-oil heaters with individual space thermostatic control.

2. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.

H. Temporary Heating and Cooling: The normal heating and/or cooling system of the building shall be maintained in operation during the construction. Should the Contractor find it necessary to interrupt the normal HVAC service to spaces, which have not been vacated for construction, such interruptions shall be pre-scheduled with the Construction Representative.

I. Temporary Telephones: Provide temporary telephone service throughout the construction period for all personnel engaged in construction activities.

1. Telephone Lines: Provide telephone lines for the following:
    a. Where an office has more than two (2) occupants, install a telephone for each additional occupant or pair of occupants.
    b. Provide a dedicated telephone for a fax machine in the field office.
    c. Provide a separate line for the Owner's use.
2. At each telephone, post a list of important telephone numbers.

J. Temporary Telephones: The Owner will provide telephones within the facility. All construction personnel will be allowed access only to those specific telephones designated by the Construction Representative.

K. Temporary Toilets: Install self-contained toilet units. Use of pit-type privies will not be permitted. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
1. Shield toilets to ensure privacy.
2. Provide separate facilities for male and female personnel.
3. Provide toilet tissue materials for each facility.

L. Temporary Toilets: Use of the Owner's existing toilet facilities will be permitted, so long as facilities are cleaned and maintained in a condition acceptable to the Owner. All construction personnel will be allowed access only to those specific facilities designed by the Construction Representative. At substantial completion, restore these facilities to the condition prevalent at the time of initial use.

M. Temporary Toilets: The Owner will provide toilets and associated facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

N. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a health and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
1. Provide paper towels or similar disposable materials for each facility.
2. Provide covered waste containers for used material.
3. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.

O. Wash Facilities: The Owner will provide wash facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

P. Drinking-Water Facilities: Provide drinking-water fountains where indicated, including paper cup supply.

Q. Drinking-Water Facilities: Provide containerized, tap-dispenser, bottled-water drinking-water units, including paper supply.
1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45°F to 55°F (7°C to 13°C).

R. Drinking-Water Facilities: The Owner will provide drinking water facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

S. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Locate field offices, storage sheds, and other temporary construction and support facilities for easy access.

1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.

B. Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at the Project site. Keep the office clean and orderly for use for small progress meetings. Furnish and equip office as follows:

1. Furnish with a desk and chairs, a 4-drawer file cabinet, plan table, plan rack, and a 6-shelf bookcase.

2. Equip with a water cooler and private toilet complete with water closet, lavatory, and medicine cabinet unit with a mirror.

C. Storage facilities: Install storage sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within the building or elsewhere onsite.

D. Storage Facilities: Limited areas for storage of building materials are available onsite. Available storage areas are shown on the drawings. The Contractor shall provide his own security. Specific locations for storage and craning operations will be discussed at the Pre-Bid Meeting and the Pre-Construction Meeting.

E. Storage Facilities: The Owner will provide storage onsite as designated by the Facility Representative or the Construction Representative. Areas for use by the Contractor for storage will be identified at the Pre-Bid Meeting.

F. Storage Facilities: No areas for storage of building materials can be made available onsite except for on the roof. Loads shall not exceed the loading limits as stated on the drawings. Roofing materials must be craned onto the roof from dedicated parking spaces as arranged by the Contractor with the City; costs of all such arrangements shall be paid by the Contractor. The Contractor shall provide his own security as he finds necessary. Specific locations for storage and craning operations will be discussed at the Pre-Bid Meeting and the Pre-Construction Meeting.

G. Storage Facilities: No areas for storage of building materials can be made available onsite. The Contractor shall provide for all storage offsite. All off-site storage locations shall be approved by the Construction Representative. The Contractor shall provide his own security as he finds necessary. The Construction Representative shall have access to the off-site storage at all times.

H. Temporary Paving: Construct and maintain temporary roads and paving to support the indicated loading adequately and to withstand exposure to traffic during the construction period. Locate temporary paving for roads, storage areas, and parking where the same permanent facilities will be located. Review proposed modifications to permanent paving with the Designer.

1. Paving: Comply with Division 2 Section "Hot-Mixed Asphalt Paving" for construction and maintenance of temporary paving.

2. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving.

3. Install temporary paving to minimize the need to rework the installations and to result in permanent roads and paved areas without damage or deterioration when occupied by the Owner.

4. Delay installation of the final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results.

5. Extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration, and supervision.

I. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting.

J. Construction Parking: Contractors must be prepared to discuss their storage and parking needs at the Pre-Bid Meeting. Parking for construction personnel cannot be provided onsite. All parking will be offsite. The Contractor will have to park on the street, in city-owned lots, or in commercial lots. Under no circumstances will any vehicle be parked in a fire lane. Parking on lawns shall be prohibited.

K. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations, and construction free of water.

L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.

1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and materials drying or curing requirements to avoid dangerous conditions and effects.

2. Install tarpaulins securely with incombustible wood framing and other materials. Close openings of 25SqFt (2.3SqM) or less with plywood or similar materials.

3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.

4. Where temporary wood or plywood enclosure exceeds 100SqFt (9.2SqM) in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.

M. Temporary Lifts and Hoists: Provide facilities for hoisting materials and employees. Truck cranes and similar devices used for hoisting materials are considered “tools and equipment” and not temporary facilities.

N. Temporary Elevator Use: Refer to Division 14 for Elevators.

O. Temporary Elevator Use: The Owner will allow use of elevators within the building. All construction personnel will be allowed access only to those specific elevators designated by the Construction Representative.

P. Project Identification and Temporary Signs: Prepare project identification and other signs of size indicated. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.

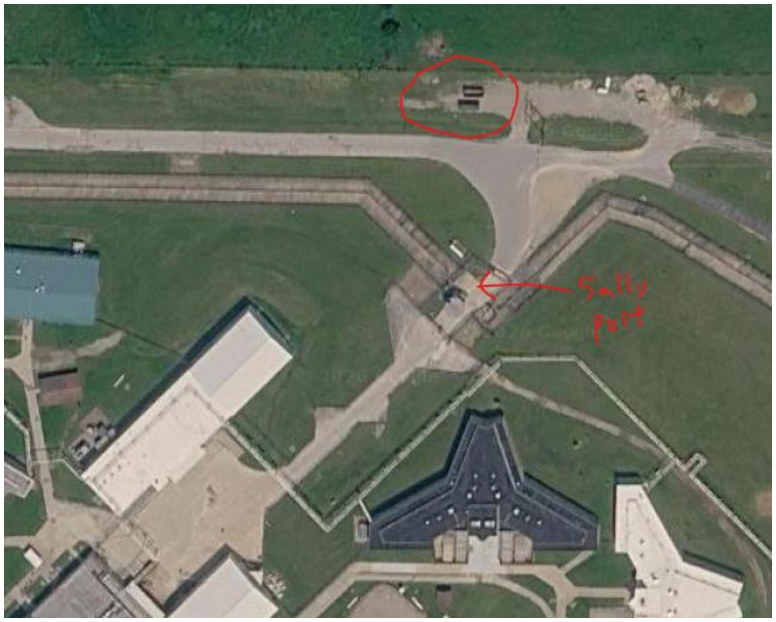
1. Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated.

2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.

Q. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.

R. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than seven (7) days during normal weather or three (3) days when the temperature is expected to rise above 80°F (27°C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

1. CONSTRUCTION DEBRIS, EQUIPMENT AND ANY REMOVED/DEMOLISHED MATERIAL SHALL BE REMOVED FROM THE SITE DAILY AND PUT IN TRASH DUMPSTERS. THE DUMPSTERS SHALL BE LOCATED OUTSIDE THE SECURITY FENCE, NORTH OF THE SALLY PORT.



S. Rodent Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Employ this service to perform extermination and control procedures are regular intervals so the Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

T. Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished, permanent stairs with a protective covering of plywood or similar material so finishes will be undamaged at the time of acceptance.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by the Designer.

B. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonable predictable and controllable fire losses. Comply with NFPA 10 “Standard for Portable Fire Extinguishers” and NFPA 241 “Standard for Safeguarding Construction, Alterations, and Demolition Operations”.

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one (1) extinguisher on each floor at or near each usable stairwell.
2. Store combustible materials in containers in fire-safe locations.
3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.
4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

C. Permanent Fire Protection: At the earliest feasible date in each area of the Project complete installation of the permanent fire-protection facility including connected services and place into operation and use. Instruct key personnel on use of facilities.

D. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting including flashing red or amber lights.

E. Enclosure Fence: Before excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.

1. Provide open-mesh, chainlink fencing with posts set in a compacted mixture of gravel and earth.
2. Provide plywood fence, 8’ (2.5m) high, framed with (4) 2”x4” (50mm x 100mm) rails, and preservative-treated wood posts spaced not more than 8’ (2.5m) apart.

F. Covered Walkway: Erect a structurally adequate, protective covered walkway for passage of persons along the adjacent public street. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Construct covered walkways using scaffold or shoring framing. Provide wood plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage. Extend the back wall beyond the structure to complete the enclosure fence. Paint and maintain in a manner acceptable to the Owner and the Designer.

G. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

1. Storage: Where materials and equipment must be stored and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

H. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.5 OPERATION, TERMINATION AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Unless the Designer requests that it be maintained longer, remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are the Contractor's property. The Owner reserves the right to take possession of project identification signs.

2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth

of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at the temporary entrances as required by the governing authority.

3. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:

   a. Replace air filters and clean inside of ductwork and housing.

   b. Replace significantly worn parts and parts subject to unusual operating conditions.

   c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 015000

SECTION 017400 – CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for cleaning during the Project.

B. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.

1. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.

2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by the manufacturer or fabricator for the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

A. General

1. Retain all stored items in an orderly arrangement allowing maximum access, not impending drainage or traffic, and providing the required protection of materials.

2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.

3. At least <once><twice> each month, and more often if necessary, completely remove all scrap, debris, and waste material from the jobsite.

4. Provide adequate storage for all items awaiting removal from the jobsite, observing all requirements for fire protection and protection of the ecology.

B. Site

1. Daily, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.

2. Weekly, inspect all arrangements of materials stored onsite. Re-stack, tidy, or otherwise service all material arrangements.

3. Maintain the site in a neat and orderly condition at all times.

C. Structures

1. Daily, inspect the structures and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.

2. Weekly, sweep all interior spaces clean. "Clean" for the purposes of this paragraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and handheld broom.

3. In preparation for installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using all equipment and materials required to achieve the required cleanliness.

4. Following the installation of finish floor materials, clean the finish floor daily while work is being performed in the space in which finish materials have been installed. "Clean" for the purposes of this subparagraph, shall be interpreted as meaning free from all foreign material which, in the opinion of the Construction Representative, may be injurious to the finish of the finish floor material.

3.2 FINAL CLEANING

A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

B. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.

1. Clean the Project Site, yard and grounds, in areas disturbed by construction activities including landscape development areas, of rubbish, waste material, litter, and foreign substances.

2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

3. Remove petrochemical spills, stains, and other foreign deposits.

4. Remove tools, construction equipment, machinery, and surplus material from the site.

5. Remove snow and ice to provide safe access to the building.

6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

8. Broom clean concrete floors in unoccupied spaces.

9. Vacuum clean carpet and similar soft surfaces removing debris and excess nap. Shampoo, if required.

10. Clean transparent material, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-

obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

11. Remove labels that are not permanent labels.

12. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

    a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

13. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

14. Clean plumbing fixtures to a sanitary condition free of stains, including stains resulting from water exposure.

15. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

16. Clean ducts, blowers, and coils if units were operated without filters during construction

17. Clean food-service equipment to a sanitary condition, ready and acceptable for its intended use.

18. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters in fluorescent and mercury vapor fixtures.

19. Leave the Project clean and ready for occupancy.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the Project of rodents, insects, and other pests. Comply with regulations of local authorities.

D. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.

E. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.

1. Where extra materials of value remain after Final Acceptance by the Owner, they become the Owner's property.

END OF SECTION 017400

SECTION 017900 - DEMONSTRATION AND TRAINING

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 instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of videographer.
c. Name of Architect.
d. Name of Construction Manager.
e. Name of Contractor.
f. Date of video recording.

2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
3. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Coordination". Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.
b. Performance and design criteria if Contractor is delegated design responsibility.
c. Operating standards.
d. Regulatory requirements.
e. Equipment function.
f. Operating characteristics.

g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project record documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.

c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 007213 "General Conditions".

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

D. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.

1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:

    a. Name of Contractor/Installer.
    b. Business address.
    c. Business phone number.
    d. Point of contact.
    e. E-mail address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.

    a. Produce segments to present a single significant piece of equipment per segment.
    b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION 017900

SECTION 024850 - LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division Specification sections, and the Approved DNR Land Disturbance Permit, apply to the Work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment and services necessary to perform all Work.

B. Work included in this Section includes clearing of weeds, seed bed preparation, installation of erosion control fabric and seeding operations required for seeding of the areas shown on Drawings.

1.3 SPECIFICATIONS AND STANDARDS

A. U.S. Department of Agriculture: SRA 156 U.S. Department of Agriculture, Rules and Regulations under the Federal Seed Act.

B. American Joint Committee on Horticultural Nomenclature Standard: 1942 Edition Standardized Plant Names.

PART 2 - PRODUCTS

2.1 SEED

A. All seed shall be furnished in sealed, standard containers, unless otherwise approved. Seed which has become wet, moldy, or otherwise damaged will not be acceptable.

B. Each container of seed shall be fully labeled in accordance with the Federal Seed Act and seed certifications shall be signed and made part of seed invoices.

C. Seed shall be Fescue, 97 percent pure live seed

D. Invoices and tags for seed shall show type furnished. Upon acceptance of the seeded areas, a final check of total quantities of seed used will be made against total area seeded and if minimum rates of application or specified quantities have not been met, the Architect will require distribution of additional quantities of these materials to make up minimum application specified.

2.2 FERTILIZER

A. Fertilizer shall be uniform in composition, free-flowing, suitable for application with approved equipment and delivered to the site unopened in original containers each bearing the manufacturer's guaranteed analysis and in conformity with state fertilizer laws. Fertilizer shall contain the following minimum percentage of plant food by weight.

1. 12 percent available nitrogen
2. 12 percent available phosphoric acid
3. 12 percent available potash

B. Fertilizer application rates shall be 600 pounds per acre with a minimum of_____lbs applied.

C. Invoices for fertilizer shall show grade furnished. Upon acceptance of the seeded areas, a final check of total quantities of fertilizer used will be made against total area seeded and if minimum rates of application or specified quantities have not been met, the Architect will require distribution of additional quantities of these materials to make up minimum application specified.

2.3 EROSION CONTROL FABRIC

A. Fabric shall be "Soil Saver" as is distributed by Jim Walls Company in Dallas, Texas (214) 239-8577; or "Curlex Blankets" as is distributed by Americal Excelsior Company in North Kansas City, Missouri (816) 842-3034; or approved equal.

2.4 STAPLES

A. **Staples are not allowed per State of Missouri Department of Corrections**.

PART 3 - EXECUTION

3.1 GROUND PREPARATION

A. General: the ground areas are to be seeded and fertilized as indicated on the Drawings and/or as specified herein. Equipment necessary for the proper preparation of the ground surface and for handling and placing all required materials shall be on hand, in good condition and shall be approved before the Work is started.

B. Clearing: Prior to tillage, seeding or other specified operations, all vegetation which might interfere with the indicated treatment of the areas shall be mowed, grubbed, raked and the debris removed from the site. Prior to or during grading and tillage operations, the ground surface shall be cleared of materials which might hinder final operations. Areas which have been disturbed shall be finish graded and/or developed as indicated on the Drawings or as specified.

C. Tillage: After the areas required to be seeded have been brought to the finish grades as specified, they shall be thoroughly tilled to a depth of at least 6 inches by plowing, disking, harrowing or other approved methods until the condition of the soil is acceptable to the Architect. Work shall be performed only during period when beneficial results are likely to be obtained. When conditions are such by reason of drought, excessive moisture, or other factors that satisfactory results are not likely to be obtained, Work shall be stopped. Work shall be resumed only when desired results are likely to be obtained.

D. Leveling: Any undulations or irregularities in the surface resulting from tillage, fertilizing or other operations shall be leveled with a float drag before seeding operations are begun.

E. Fertilizing: Fertilizer shall be distributed uniformly at the rate previously specified per 1,000 square feet over the areas to be seeded and shall be incorporated into the soil to a depth of at least 3 to 4 inches by disking, harrowing or other approved methods. The incorporation of fertilizer may be a part of the tillage operation hereinbefore specified. Distribution by means of an approved seed drill equipped to sow seed and distribute fertilizer at the same time will not be accepted. Fertilizer shall be incorporated into the soil a minimum of 10 days before seed is planted.

F. Inspection: A minimum of 48 hours prior notice must be given to the Construction Administrator before fertilizing may commence.

G. Planting Time: All seeding Work shall be done between the dates of April 1 to May 15 for spring planting and from August 15 to October 15 for fall planting except as otherwise directed in writing by the Construction Administrator.

H. Planting Condition: No planting shall be done until a permanent source of water is available at the site for use by the Owner.

3.2 SEEDING

A. General: Prior to seeding, any previously prepared seedbed areas compacted or damaged by interim rains, traffic, or other cause shall be reworked to restore the ground condition previously specified. Seed shall be planted by drill seeding.

B. Drill Seeding: Seed shall be uniformly drilled to an average depth of ½ inch and at the rate of 8 pounds per 1,000 square feet using equipment having drills not more than 6 ½ inches apart. Row markers shall be used with the drill seeder.

C. Rolling: Immediately after seeding, except for slopes 3 horizontal to 1 vertical and greater, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Do not roll areas seeded with seed drills equipped with rollers.

D. Inspection: A minimum of 48 hours prior notice must be given to the Construction Administrator before seeding may commence.

3.3 INSTALLATION OF EROSION CONTROL FABRIC

A. Fabric shall be rolled out in place. Fabric shall be applied without stretching and shall lie smoothly but loosely on the soil surface. The Contractor shall refer to the Drawings for details of fabric fastening.

B. Application of the erosion control fabric shall occur the same day that the seeding of an area has taken place.

C. Fabric shall completely cover all areas which are shown on the Drawings to be protected from erosion. After fabric installation, the entire area shall be rolled with a smooth roller weighing between 200 to 250 pounds. After rolling, the fabric shall be in intimate contact with the soil surface at all points. Any clods, etc., which hold the fabric off the ground should be removed. The fabric shall be forced down into any depressions.

3.4 MAINTENANCE

A. General: The project areas shall be kept clean at all times and care shall be taken that use of the premises shall not be unduly hampered by Work herein specified. The intent of this Section is to ensure a healthy, well-established turf, and prevent soil erosion in compliance with the Land Disturbance Permit issued by the Missouri Department of Natural Resources.

B. Responsibility: The Owner shall be responsible for maintenance of all seeded areas upon completion of seeding and general acceptance by the Construction Administrator.

C. Damage: Damage to seeded areas during the project shall be repaired by the persons responsible for causing such damage.

3.5 GENERAL ACCEPTANCE

A. The Construction Administrator shall make an inspection of the seeded areas upon completion of seeding. Seeded areas shall be considered acceptable if the specified quantities of fertilizer & seed have been properly applied.

3.6 GUARANTEE

A. The Contractor is responsible for the proper application of the fertilizer & seeding. Watering, weeding, re-seeding, and mowing will be the responsibility of the Owner after proper application of the seed.

END OF SECTION 024850

SECTION 040120.63 - BRICK MASONRY REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes repairing and infill of brick masonry.

1.2 DEFINITIONS

A. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conference location to be determined.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

PART 2 - PRODUCTS

2.1 MASONRY MATERIALS

A. Face Brick: As required to complete brick masonry repair work.

1. Brick Matching Existing: Units with colors, color variation within units, surface texture, size, and shape that match existing brickwork.

a. For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white[or gray, or both] where required for color matching of mortar.

B. Hydrated Lime: ASTM C207, Type S.

C. Masonry Cement: ASTM C91/C91M.

D. Mortar Cement: ASTM C1329/C1329M.

E. Mortar Sand: ASTM C144.

1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

F. Water: Potable.

2.3 MANUFACTURED REPAIR MATERIALS

A. Brick Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching brick masonry.
1. Use formulation that is vapor and water permeable (equal to or more than the brick), exhibits low shrinkage, has lower modulus of elasticity than bricks being repaired, and develops high bond strength to all types of masonry.
2. Formulate patching compound in colors and textures to match each brick being patched.

2.4 ACCESSORY MATERIALS

A. Setting Buttons and Shims: Resilient plastic, nonstaining to masonry, sized to suit joint thicknesses and bed depths of bricks, less the required depth of pointing materials unless removed before pointing.

2.5 MORTAR MIXES

A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.

1. Do not use admixtures in mortar unless otherwise indicated.

C. Mixes: Mix mortar materials in the following proportions:

1. Rebuilding (Setting) Mortar by Volume: ASTM C270, Proportion Specification, [1 part portland cement, 1 part lime, and 6 parts sand]

2.6 Ties and Anchors

A. General: Ties and anchors shall 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. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

C. Adjustable Anchors for Connecting to Concrete/CMU: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plan of wall.

1. Barrel type system consisting of a one-piece screw, barrel, washer, flanged head and eye designed to seat barrel directly on structural position of backup, with flanged head covering fastener hole. No. 75: Heckmann "Pos-I-Tie" Concrete/ CMU Screw anchoring system that comply with ACI 530.1/ASCE 6/TMS 602.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch (4.76mm) diameter hot-dip galvanized-steel wire.

2.7 Embedded Flashing Materials

A. Metal Flashing: Provide metal flashing complying with Section 07 6200 "Sheet Metal Flashing and Trim" and as follows:

1. Fabricate metal drip edges from stainless steel (Type 304). 0.016 inch thick. Extend at least 3 inches (76 mm) into wall and ½ inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

B. Flexible Flashing: Use the following unless otherwise indicated:

1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.76 mm).

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Carlisle Coatings & Waterproofing Inc.
2) Grace Construction Products; W.R. Grace & Co. – Conn.
3) Hohmann & Barnard, Inc.
4) Polyguard Products, Inc.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

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.

2.8 Miscellaneous Masonry Accessories

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

PART 3 - EXECUTION

3.1 BRICK MASONRY PATCHING

A. Patching Bricks:

1. Remove loose material from masonry surface. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch (6 mm) thick, but not less than recommended in writing by patching compound manufacturer.
2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of brick.
3. Rinse surface to be patched and leave damp, but without standing water.
4. Brush-coat surfaces with slurry coat of patching compound according to manufacturer's written instructions.
5. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
6. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of brick. Shape and finish surface before or after curing, as determined by testing, to best match existing brick.
7. Keep each layer damp for 72 hours or until patching compound has set.

3.2 FINAL CLEANING

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, applied by low pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

END OF SECTION 040120.63

SECTION 042213 – STRUCTURAL REINFORCED CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 CODES AND STANDARDS

A. All concrete masonry construction shall conform to the requirements of the local building code and the Specification for Concrete Masonry Structures, ACI 530.1/ASCE 6/TMS 602.

1.3 DESCRIPTION OF WORK

A. Extent of each type of reinforced unit masonry work is indicated on the architectural and structural drawings and in schedules. Provide all labor, materials, equipment, and services necessary for and incidental to the installation of all reinforced masonry construction as indicated on the drawings and specified herein.

B. Reinforced unit masonry construction includes reinforced concrete masonry including concrete filled masonry beams, columns, pilasters, lintels, and soffits.

C. Accessories include, but are not necessarily limited to ties, horizontal and vertical reinforcement, anchors to the structure, and control joints.

D. The masonry contractor shall install all accessory items that are required in the work and supplied by others, including: bolts, nailing blocks, inserts, anchors, flashing, steel lintels, expansion joints, conduits, cast-stone trim, hollow-metal door frames, etc.

E. Types of masonry work required include Concrete unit masonry (CMU).

1.4 QUALITY ASSURANCE

A. Fire Performance Characteristics: Where indicated, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E 119 by a recognized testing and inspecting organization or by another means, as acceptable to authority having jurisdiction.

B. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

C. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements. Provide certification of pull-out strength of all masonry ties and anchors. Submit certification of compliance with required standards for all masonry units.

B. Shop Drawings: Show fabrication and installation details for the following:

1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars and for templates for layout of dowels for columns and pilasters. Comply with the fabrication tolerances of ACI 315, "Details and Detailing of Concrete Reinforcement." Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcement for unit masonry work.

C. Mix Designs:

1. Mortar mix proportions for type of mortar required to achieve specified compressive strength of masonry.
2. Mix designs and mortar tests performed in accordance with ASTM C 270
3. Grout mix proportions according to ASTM C476 for the types of grout required for the work.
4. Mix designs and grout tests performed in accordance with ASTM C 476.

D. Certificates: Prior to delivery, submit to Architect/Engineer certificates attesting compliance with the applicable specifications for grades, types or classes of all products included in these specifications.

1. All materials required for mortar and grout including type, source, brand, and name of manufacturer.
2. Each combination of masonry unit type and mortar type. Include statement of net area compressive strength of masonry units, mortar type and net compressive strength of masonry determined according to Table 2 in ACI 530.1/ASCE 6/TMS 602.
3. Mill Certificates: Steel producer's certificates of mill analysis, tensile and bend test for reinforcing steel required for project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes During freezing weather, protect masonry units with tarpaulins or other suitable material. If units become wet, do not install until they are dry.

C. At the time of delivery, the linear shrinkage of masonry units shall not exceed 0.065 percent.

D. Store cementitious materials and masonry units off the ground, under cover and in dry location. All materials must be protected from wetting by capillary action, rain, or snow, and protected from mud, dust, or other materials and contaminants likely to cause staining or defects.

E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying in dispensing silo. Store preblended, 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.

F. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

G. Store masonry accessories, including metal items, in such a way as to prevent corrosion or accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Work: The Contractor shall construct and maintain temporary protection as required to permit continuous progress of the work. During erection, cover top of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of the other wythes, secure cover a minimum of 24 inches down the face next to unconstructed wythe and hold cover in place.

B. 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 ACI 530.1/ASCE 6/TMS 602.

C. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

1. When ambient temperature exceeds 100 degrees F or 90 degrees F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.
2. Comply with hot-weather preparation and construction provisions of ACI 530.1/ASCE 6/TMS 602

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Comply with referenced standards and other requirements indicated below applicable to each form of concrete masonry unit required.

B. Provide special shapes where required for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions. All special shapes provided shall match approved samples available for inspection at the Architect's office.

C. Provide square-edged units for outside corners, except where indicated as bullnose.

D. Provide units complying with the characteristics indicated below for type, size, strength, and weight.
   1. Hollow Loadbearing Block: ASTM C 90 Normal Weight.
   2. Unit Compressive Strength: Provide units with a minimum average net-area compressive strength of 2,000 psi.
   3. Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" high (15-5/8" x 7-5/8" actual) x thicknesses indicated unless shown otherwise on the drawings.

2.2 MORTAR AND GROUT MATERIALS

A. Do not use calcium chloride in mortar or grout.

B. Mortar: ASTM C 270, Proportion Specification, Type M or S, limiting cementitious materials to those described below:
   1. Portland Cement-Lime
   2. Mortar Cement

C. Grout: Provide grout that conforms to either of the two requirements below:
   1. The material requirements of ASTM C 476; attains the specified compressive strength or 2000 psi, whichever is greater, at 28 days when tested in accordance with ASTM C 1019; has a slump flow of 24 in. to 30 in. as determined by ASTM C 1611; and has a Visual Stability Index (VSI) less than or equal to 1 as determined in accordance with ASTM C1611.
   2. Grout consistency is to be coarse grout unless fine grout is required by ACI530.1/ASCE6/TMS602 based on minimum grout space dimensions coupled with maximum pour heights or unless a stricter requirement is defined by the local code.

2.3 REINFORCING STEEL

A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60.

2.4 JOINT REINFORCEMENT, TIES AND ANCHORING DEVICES

A. General:

1. Comply with requirements indicated below for basic materials and with requirements indicated under each form of joint reinforcement, tie and anchor for size and other characteristics.
2. Manufacturers:

    a. Subject to compliance with requirements, provide products of one of the following:

        1) AA Wire Products Co.
        2) Dur-O-Wall, Inc.
        3) Hohmann & Barnard, Inc.
        4) National Wire Products Corp.
        5) Heckman Building Products

    b. Other manufacturers shall be used only with Engineer approval. The Contractor shall submit technical literature for all reinforcing units.

3. Finishes: Provide reinforcement, ties, and anchors specified in subsequent paragraphs that are made from materials or that have the finishes that comply with the subparagraphs below, depending on the finish specified, unless otherwise indicated.

    a. Mill Galvanized Finishes

        1) Joint Reinforcement: ASTM A 641 (0.1 oz/ft^2).
        2) Sheet-metal ties and anchors: ASTM A 653 G60.

    b. Hot-Dip Galvanized Finishes

        1) Joint Reinforcement, Wire Ties, Wire Anchors: ASTM A 153, (1.5 oz/ft^2).
        2) Sheet-metal Ties and Anchors: ASTM A 153, Class B.
        3) Steel Plates and Bars: ASTM A 123 or ASTM A 153, Class B.

    c. Epoxy Coatings:

        1) Joint Reinforcement: ASTM A 884, Class A, Type 1 ≥ 7 mils.
        2) Wire Ties and Anchors: ASTM A 889, Class C – 20 mils.
        3) Sheet-metal Ties and Anchors: 20 mils per surface or manufacturer's specification.

B. Bent Wire Ties: Provide individual prefabricated bent-wire units complying with requirements indicated below:

1. Materials and Finishes:

    a. Galvanized: ASTM A 82.
    b. Epoxy: ASTM A 82.
    c. Stainless Steel: ASTM A 580.

2. Wire Size: 0.1875" diameter.
3. Length: Provide units of length indicated but not less than that required for embedment of at least 1 ½ " into the mortar bed of solid units or solid grouted hollow units and for a

minimum of 1/2" embedment of tie end into outer face shells of hollow units, with not less than 5/8" mortar cover on exterior face joints, 1/2" elsewhere.

4. Tie Shape for Hollow Masonry Units Laid with Cells Vertical: Rectangular with ends welded closed and not less than 4" wide.
5. Tie Shape for Solid Masonry Units or hollow units laid with cells horizontal: Z-shaped ties with ends bent 90° to provide hooks not less than 2" long.
6. Type for Masonry Where Coursing Between Wythes Align: Unit ties bent from one piece of wire.
7. Type for Masonry Where Coursing Between Wythes Does Not Align: Adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 “. The maximum clearance between connecting parts of the tie shall be 1/16”.

C. Adjustable Anchors: Where adjustable anchors are indicated for connecting masonry to structural framework, provide 2-piece assemblies as described below which permit vertical or horizontal differential movement between wall and framework parallel to, but resist tension and compression forces perpendicular to, plane of wall.

1. Materials and Finishes:
   a. Galvanized: ASTM A 82 for wire and ASTM A 1008 for sheet metal.
   b. Epoxy: ASTM A 82 for wire and ASTM A 1008 for sheet metal.
   c. Stainless Steel: ASTM A 580 for wire and ASTM A 480 and ASTM A 240 for sheet metal.

2. For anchorage to concrete framework, provide manufacturer's standard anchors with dovetail anchor section formed from 0.0966" thick sheet metal and triangular-shaped wire tie section sized to extend within 1" of masonry face.
3. For anchorage to steel framework provide manufacturer's standard anchors with crimped 1/4" diameter wire anchor section for welding to steel and triangular-shaped wire tie section sized to extend within 1" of masonry face.
4. Wire Size for triangular section: 0.1875" diameter.

D. Rigid Anchors: Provide straps of form and length indicated, fabricated from sheet metal strips of following width and thickness, unless otherwise indicated. Typical length to be 24" plus 2" long, 90° bends at ends.

1. Material and Finishes:

   a. Galvanized: ASTM A 1008.
   b. Epoxy: ASTM A 1008.
   c. Stainless Steel: ASTM A 480 and ASTM A 240.

2. Width: 1-1/2".
3. Thickness: 1/4".

E. Unit Type Masonry Inserts in Concrete: Furnish cast iron or malleable iron inserts of type and size indicated.

F. Dovetail Slots: Furnish dovetail slots, with filler strips, of slot size indicated, fabricated from 0.0336" (22 gage) sheet metal, ASTM A 1008, Hot-dip galvanized.

G. Anchor Bolts: Provide steel bolts with hex nuts and flat washers complying with ASTM A 307, Grade A, hot-dip galvanized to comply with ASTM A 153, Class C, in sizes and configurations indicated.

H. Post-installed Anchors:

1. ICC Approval: Only anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) with a published Evaluation Report specifically addressing anchorage to hollow or fully grouted concrete masonry shall be approved for use.
2. Type:

a. Hollow Concrete Masonry: Anchors into or through hollow concrete masonry units shall be the chemical type used with a galvanized or stainless steel screen tube that allows the chemical adhesive to create a key within the hollow cell of the unit.
b. Fully Grouted Concrete Masonry: Anchors into fully grouted masonry shall be either chemical anchors or expansion anchors specifically approved by ICC-ES for use in fully-grouted concrete masonry.

3. Finish:

a. Interior Exposure: All anchors, nuts and washers for use in interior environments free of potential moisture shall be manufactured from carbon steel, zinc plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3.
b. Exterior or Exposed Use: All anchors, nuts, and washers for use in exposed or potentially wet environments, or for attachment of exterior cladding materials shall be galvanized or stainless steel. Galvanized anchors, nuts and washers shall conform to ASTM A 153. Stainless steel anchors shall be manufactured from 300 series stainless steel and nuts and washers from 300 series or Type 18-8 stainless steel.

2.5 MISCELLANEOUS MASONRY ACCESSORIES

A. Non-Metallic Expansion Joint Strips: Premolded, flexible cellular neoprene rubber filler strips complying with ASTM D 1056, Grade RE 41E1, capable of compression up to 35%, of width and thickness indicated.

B. Premolded Control Joint Strips: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

1. Premolded PVC Control Joint Strips. Strips shall be polyvinyl chloride complying with ASTM D 2287, Type PVC 654-4 with a durometer hardness of 85±5.

C. Weepholes: Cotton Cord: Sash cord of length required to produce 2" exposure on exterior and 18" in cavity between wythes.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Inspect surfaces that are to support masonry work to assure completion to proper lines and grades and are free of dirt and other deleterious material. Do not begin work until surfaces not properly prepared have been satisfactorily corrected.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
2. Verify that foundations or other supporting surfaces are within specified tolerances.
3. Verify that reinforcing dowels are properly spaced.
4. Examine rough-in and built-in construction to verify actual locations of piping connections.

B. The horizontal and vertical spacing between anchors tying the masonry wall to the structural frame shall be as indicated on the drawings. Intersecting walls may substitute for an anchor.

C. Cleaning Reinforcing: Before placing, remove loose rust, ice and other coatings from reinforcing.

D. Installation of Masonry, General:

1. Build cavity and composite walls, floors and other masonry construction to the full thickness shown. Build single-wythe walls (if any) to the actual thickness of the masonry units, using units of nominal thickness indicated.
2. Build chases and recesses as shown or required for the work of other trades. Provide not less than 8" of masonry between chase of recess and jamb of openings, and between adjacent chases and recesses.
3. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.
4. Cut masonry units using motor-driven dry-cutting or water-cooled saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous patterns and to fit adjoining work. Use full-size units without cutting where possible.
5. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Do not install cracked, broken, or chipped masonry units exceeding ASTM allowances.

F. Protect sills, ledges, and offsets from mortar droppings or other damage during construction. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface. Remove misplaced mortar or grout immediately. Protect face materials against staining. Protect door jambs and corners from damage during construction.

G. Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Immediately remove grout or mortar in contact with such masonry.

H. Matching Existing Masonry Work: Match coursing, bonding, color and texture of new masonry work with existing work.

I. Mixing Mortar and Grout: Comply with the requirements of ACI 530.1/ASCE 6/TMS 602.

3.2 CONSTRUCTION TOLERANCES

A. Comply with tolerance in ACI 530.1/ASCE 6/TMS 602 and the following.

B. For conspicuous vertical lines such as external corners, reveals, expansion and control joints, do not exceed 1/4" in any story or 20 feet maximum, nor 1/2" maximum.

C. For vertical alignment of exposed head joints do not vary from plumb by more than 1/4" in 10 feet, nor 1/2" maximum.

D. Variation from Level: For conspicuous horizontal lines such as exposed lintels, sills, parapets, and reveals, do not exceed 1/4" in any bay or 10 feet maximum, nor 1/2" maximum. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10 feet or 1/16" within width of a single unit.

3.3 LAYING MASONRY WALLS

A. Do not wet concrete masonry prior to laying up units unless written permission is obtained from the Engineer.

B. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate location of openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units, particularly at corners, jambs and wherever possible at other locations.

C. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

D. Bond Pattern for Exposed Masonry: Lay exposed masonry to match existing bond pattern.

E. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4" horizontal face dimensions at corners or jambs.

F. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond or one-third unit for one-third running bond. Do not tooth. Clean exposed surfaces at set masonry and remove loose masonry units and mortar prior to laying fresh masonry.

G. Built-in Work: Install bolts, anchors, nailing blocks, inserts, frames, vent flashings, conduit, and other built-in items specified under this and other sections of these specifications as masonry work progresses. Avoid cutting and patching. Solidly grout spaces around built-in items. Provide joints around exterior framed openings 1/4" to 3/8" wide, raked and tooled smooth to a uniform depth of 3/4", ready for caulking by others. Build chases, do not cut. Consult other trades in advance and make provisions for installation of their work to avoid cutting and patching. Install chases minimum of one full masonry unit length from jambs.

1. Fill in space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core, unless detailed otherwise.
3. Fill cores in hollow concrete masonry units with grout to supporting beam or slab below under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

H. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.

1. For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units, in addition to masonry bonding.

I. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:

1. Provide individual metal ties at not more than 16" o.c. vertically.
2. Provide continuity with horizontal joint reinforcement using prefabricated "T" units.

J. Intersecting Load-bearing Walls: If carried up separately, block or tooth vertical joint with 8" maximum offsets and provide rigid steel anchors spaced not more than 4'-0" o.c. vertically, or omit blocking and provide rigid steel anchors at not more than 2'-0" o.c. vertically. If used with hollow masonry units, embed ends in mortar-filled cores.

3.4 MORTAR BEDDING AND JOINTING

A. Provide uniform nominal joint thickness of 3/8” for concrete masonry units, unless noted otherwise on the drawings.

B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells of cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

C. Joint Profile: Provide weather-proof, concave, tooled joints in exposed surfaces when mortar is thumbprint hard, using round jointing tool. Strike joints flush in surfaces to be plastered, stuccoed, or covered with other material or surface-applied finish other than paint. Concave tool exterior joints below grade. Remove mortar protruding into cells or cavities to be grouted. Do not permit mortar droppings to block weep holes. Do not fill horizontal joints between top of masonry partitions and underside of concrete or steel construction with mortar unless specifically shown on the drawings. If not shown otherwise, provide 1" clear joint to be filled with caulk. Keep movement joints clean of all mortar and debris. For tuckpointing, rake mortar joints to a depth of 1/2 to 3/4 in., saturate with clean water, fill solidly with pointing mortar, and tool to match existing joints.

D. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners of jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

E. Collar Joints: Unless otherwise required, After each course is laid, fill the vertical longitudinal joint between wythes solidly with mortar (grout if walls are grouted) for the following masonry work:

1. All multi-wythe walls of concrete masonry units in which the collar joint between wythes is less than ¾".
2. All below grade conditions.

3.5 CONSTRUCTION STABILITY

A. Design, provide and install bracing that will assure stability of masonry during construction.

B. Allow 16 hours to elapse after completion of masonry columns and walls before placing floor or roof construction loads. Allow an additional 48 hours before applying concentrated loads such as girders, beams, or trusses.

3.6 CAVITY WALLS

A. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity flush.

B. Provide weep holes in head joints in first course immediately above all flashing. Leave head joint free and clean of mortar or install weep hole tube in head joint. Space weep holes 32" on center maximum for concrete unit masonry. Keep weep holes and area above

3.7 HORIZONTAL JOINT REINFORCEMENT

A. General:

1. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 6" at splices.
2. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
3. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.
4. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
5. Space continuous horizontal reinforcement as follows:
    a. For single-wythe walls, space reinforcement at 16" o.c. vertically, unless otherwise indicated.
    b. For parapets, space reinforcement at 8" o.c. vertically, unless otherwise indicated.
    c. For perforated masonry screen walls, space reinforcement at every other course vertically, not to exceed 16” o.c., unless otherwise indicated.
    d. For concrete masonry cantilever walls and fences, space reinforcement at 8" o.c. vertically, unless otherwise indicated.

e. For walls utilizing a stack bond pattern, space reinforcement at 8” o.c. vertically, unless otherwise indicated.

6. Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcement placed in two horizontal joints approximately 8" apart, immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints. Horizontal joint reinforcement interrupted by the jamb of an opening shall have the cross rod or side rod bent and hooked at the jamb. Provide an additional rectangular adjustable tie at the jamb for each joint not containing the normal horizontal reinforcing unit.
7. Provide reinforcement at openings in addition to other specified wall reinforcement.

3.8 PLACING REINFORCEMENT

A. General: Clean reinforcement of loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes.

B. Position reinforcement accurately at the spacing indicated. Prior to grouting, support and secure vertical bars against displacement. Vertical bars shall be held in position at the top and bottom and at intervals not exceeding 8'-0" with a minimum clearance of 1/4" if fine grout is used or 1/2” if coarse grout is used from the face of the masonry and not less than one bar diameter or 1" (whichever is greater) between adjacent bars.

C. For columns, piers and pilasters, provide a clear distance between vertical bars as indicated, but not less than 1-1/2 times the nominal bar diameter or 1-1/2", whichever is greater. Provide lateral ties as indicated.

D. All dowels shall be grouted into a cell even if the dowel is in an adjacent cell to the vertical steel. Unless detailed otherwise on the drawings, dowels shall be the same size and number as the vertical steel. Unless noted otherwise provide a lap length of dowels to vertical reinforcement equal to 50 times the nominal dowel diameter.

E. All horizontal reinforcing steel shall be placed in continuous bond beam or lintel block units and shall be solidly grouted in place. Maintain a minimum of one bar diameter or 1" (whichever is greater) clearance between adjacent bars and a minimum of 1/4" clearance if fine grout is used or 1/2” if coarse grout is used from the face of the masonry. Horizontal reinforcement may be placed as the masonry work progresses.

F. Splice reinforcement bars where shown; do not splice at other points unless acceptable to the Engineer. Where splices occur, adjacent splices shall be staggered so that no more than 25% of the total number of bars is spliced at any one point with a minimum stagger between splices in adjacent bars of at least the lap length. Provide lapped splices, unless otherwise indicated. In splicing vertical bars or attaching to dowels, lap ends, place in contact and wire tie. Minimum lap splice length shall be 50 bar diameters unless indicated otherwise.

G. Where reinforcement is prefabricated into cage units before placing, fabricate units with vertical reinforcement bars and lateral ties of the size and spacing indicated.

3.9 GROUTING

A. General: Grout all cells of masonry walls, columns, and pilasters. Fully grout vertical cells of concrete masonry containing steel reinforcement.

B. Specification: Comply with the requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts, grout space preparation, and grout placement, including minimum grout space, maximum pour height, maximum lift height and consolidation.

1. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
2. Place grout in lintels or beams over openings in one continuous pour.
3. Where bond beam occurs more than one course below top of pour and vertically reinforced cells are present above the bond beam, fill bond beam course to within 1-1/2" of the top of the bond beam.
4. When more than one pour is required to complete a given section of masonry, extend reinforcement beyond masonry as required for splicing. Pour grout to within 1-1/2" of top course of first pour. After grouted masonry is cured, lay masonry units and place reinforcement for second pour section before grouting. Repeat sequence if more pours are required.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Provide vertical and horizontal expansion, control and isolation joints in masonry where shown. Build-in related items as the masonry work progresses.

B. Where control joints are not indicated on the drawings the Contractor shall submit a proposed control joint layout for Architect and Engineer approval. General guidelines for control joint locations are as follows:

1. At major changes in wall height.
2. At changes in wall thickness.
3. At corresponding control joints in foundations, floor, or roof construction.
4. At one or both sides of wall openings (masonry veneer only).
5. Near wall intersections.
6. At column centerlines.

C. Maximum Spacing: Maximum control joint spacing in concrete masonry construction shall be such that the ratio of wall length to height shall not exceed 1.5 with a maximum spacing of 25 feet.

D. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete.

E. Build in horizontal pressure relieving joints where indicated; construct joints by inserting non-metallic compressible joint filler of width required to permit installation of sealant and backer rod.

F. Provide continuous bond break at steel columns and members.

G. Provide pressure-relieving joints by adhering a continuous 3/8" thick neoprene pad below shelf angles supporting masonry veneer.

H. Leave joints around outside perimeters of exterior doors, window frames and other wall openings:

1. Depth: Uniform 3/4 in. (19mm).
2. Width: 1/4 in. (6.4 mm) to 3/8 in. (9.5mm).

3.11 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and wherever openings of more than 2'-0" for block size units are shown without structural steel or other supporting lintels.
1. For hollow concrete masonry unit walls, use specially formed U-shaped lintel units with reinforcement bars placed as shown filled with coarse grout.

C. Provide minimum bearing as noted on the drawings.

3.12 PARGING

A. Parge walls where indicated with Type S or N mortar, in thickness indicated. Thickness: Not less than 1/2".

B. Trowel finish to a smooth, dense surface. Form a wash at top of parging and a cove at bottom. Where parging is applied in 2 coats, roughen first coat when partially set, let harden for 24 hours and moisten prior to application of second coat.

C. Damp cure parging for at least 24 hours and protect until cured.

3.13 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing:

1. During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Pointup all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants. If the repairs must be made after the mortar has hardened, the joint must be raked or chiseled out to a depth of about 1/2" thoroughly wetted, and repointed with fresh mortar.

2. To prehydrate mortars, thoroughly mix all ingredients except water in proportions used for original mortar mix; then mix again, adding only enough water to produce a damp unworkable mix which will retain its form when pressed into a ball. After 1 to 2 hours, add sufficient water to bring it to the proper consistence; that is conventional masonry mortars.

C. Final Cleaning: After mortar is thoroughly set and cured, clean masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. 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.
4. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clean water.
5. Clean concrete unit masonry to comply with masonry manufacturer's directions and NCMA Tek 8-2 bulletin.

D. Protection and Cleanup:

1. Provide final protection and maintain conditions in a manner acceptable to Installer, which ensure unit masonry work being without damage and deterioration at time of substantial completion.
2. Leave work area and surrounding surfaces clean and free of mortar spots, droppings, and broken masonry.

3.14 QUALITY ASSURANCE TESTING AND INSPECTION DURING CONSTRUCTION

A. The Owner will engage a special inspector and a qualified independent testing and inspection agency to perform field tests and inspections and prepare reports thereof.

B. Verification Testing Frequency: Verification of masonry strength (f'm) will be performed at the beginning of masonry construction and during construction for each 5000 square feet of wall area or portion thereof.

C. Concrete Masonry Unit: For each type of concrete masonry unit indicated, verify compliance with ASTM C90 and the strength required by design. Verification may be by reviewing certification from unit producer showing compliance.

D. Mortar:

1. Throughout construction, verify the proportions of the site-prepared mortar mix comply with the requirements of ASTM C270 for the type specified.
2. Verify the proportions of materials in premixed or preblended mortar comply with the requirements of ASTM C270 for the type specified as delivered to the site.

E. Grout:

1. Prior to grouting, verify the proportions of site-prepared grout mix comply with the requirements of ASTM C476 for each type of grout used.
2. Verify the proportions of materials in premixed or preblended grout comply with the requirements of ASTM C476 as delivered to the site.

F. Mortar Joints: Throughout construction, verify that mortar joints are being prepared in accordance with these specifications and ACI 530.1/ASCE 6/TMS 602.

G. Reinforcement and Connectors: Prior to grouting, verify the size, grade, type and placement of reinforcement and connectors is in compliance with specified requirements.

H. Grouting: Prior to any grouting procedure, the grout space shall be inspected to verify that it is clean and that cleanouts, if required, are in place and conform to requirements. Verify through continuous inspection that the placement of grout is in compliance with the requirements of the contract specifications and ACI 530.1/ASCE 6/TMS 602.

I. Anchors: Periodically verify the type, size and location of anchors including anchors of masonry to other structural members, frames, or construction is in compliance with specified requirements.

J. Installed items: Verify that installed flashing, weep holes, construction joints, control joints and wall vents are installed in accordance with specifications.

END OF SECTION - 042213

SECTION 04 2613 - MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clay face brick.

B. Products Installed but Not Furnished under This Section:

1. Steel lintels in masonry veneer.
2. Steel shelf angles for supporting masonry veneer.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type and color of brick.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product.

1.4 FIELD CONDITIONS

A. 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/ACI 530.1/ASCE 6.

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.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, 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 will be exposed in the completed Work.

2.2 BRICK

A. Shapes: 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 shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C 216.

1. Provide blended color and texture to match existing brick.

2. Grade SW.
3. Type FBX.
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Size: Modular/ (Actual Dimensions): to match dimension of brick on existing building
7. Color and Texture: Provide blended color and texture to match existing.

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C 150/C 150M, 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.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.

1. White-Mortar Aggregates: Natural white sand or crushed white stone.
2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
3. Provide color to match mortar on existing building.

E. Water: Potable.

2.4 TIES AND ANCHORS

A. General: Ties and anchors shall 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. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

C. Adjustable Anchors for Connecting to Concrete/CMU: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plan of wall.

1. Barrel type system consisting of a one-piece screw, barrel, washer, flanged head and eye designed to seat barrel directly on structural position of backup, with flanged head covering fastener hole. No. 75: Heckmann “Pos-I-Tie” Concrete/ CMU Screw anchoring system that comply with ACI 530.1/ASCE 6/TMS 602.
2. Tie Section: Triangular-shaped wire tie made from 0.187 inch (4.76mm) diameter hot-dip galvanized-steel wire.

2.5 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 07 6200 “Sheet Metal Flashing and Trim” and as follows:

1. Fabricate metal drip edges from stainless steel (Type 304). 0.016 inch thick. Extend at least 3 inches (76 mm) into wall and ½ inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

B. Flexible Flashing: Use the following unless otherwise indicated:

1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.76 mm).

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Carlisle Coatings & Waterproofing Inc.
2) Grace Construction Products; W.R. Grace & Co. – Conn.
3) Hohmann & Barnard, Inc.
4) Polyguard Products, Inc.
5) W.R. Meadows, Inc.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 07 6200 “Sheet Metal Flashing and Trim.”

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.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Weep/Vent Products: Use the following unless otherwise indicated:

1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Advanced Building Products Inc.
2) CavClear/Archovations, Inc.
3) Keene Building Products.
4) Mortar Net USA, Ltd.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advanced Building Products Inc.
b. CavClear/Archovations, Inc.
c. Heckmann Building Products, Inc.
d. Hohmann & Barnard, Inc.
e. Mortar Net USA, Ltd.

2. Configuration: Provide one of the following:

a. Strips, full depth of cavity and 10 inches (250 mm) high, with dovetail-shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.
b. Strips, not less than 1-1/2 inches (38 mm) thick and 10 inches (250 mm) high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.

2.7 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: 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 division of Sandell Construction Solutions.
b. EaCo Chem, Inc.
c. PROSOCO, Inc.

2.8 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 in mortar or grout.
2. Use Portland cement-lime mortar unless otherwise indicated.
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 C 270, Proportion Specification. Use Type N unless another type is indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. 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.

B. 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.

C. 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 according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus ½ inch (12 mm) or minus ¼ inch (6 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus ½ inch (12 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus ¼ inch (6 mm) in a story height or ½ inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than ¼ inch in 10 feet (6 mm in 3 m), or ½ inch (12 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 feet (3 mm in 3 m), ¼ inch in 20 feet (6 mm in 6 m), or ½ inch (12 mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than ¼ inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or ½ inch (12 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 feet (3 mm in 3 m), ¼ inch in 20 feet (6 mm in 6 m), or ½ inch (12 mm) maximum.

5. For lines and surfaces, do not vary from straight by more than ¼ inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or ½ inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to ½ inch (12 mm).
2. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.3 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 clay brick masonry to match existing pattern; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

3.4 MORTAR BEDDING AND JOINTING

A. Lay 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.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.5 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.
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 25 inches (635 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically, with not less than one anchor for each 2.67 sq. ft. (0.25 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 not less than [2 inches (50 mm)] of airspace between back of masonry veneer and face of insulation.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 2 inches (50 mm) wide between masonry and concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.7 FLASHING, WEEP HOLES, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, 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. Extend flashing through veneer, across airspace behind veneer and up face of sheathing at least 12” with upper edge tucked behind termination bar.
3. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
4. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing ½ inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.

C. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.

D. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in “Miscellaneous Masonry Accessories” Article.

E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.8 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. 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 shall be done at Contractor’s expense.

B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

C. Testing Prior to Construction: One set of tests.

D. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

3.9 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Protect adjacent non-masonry surfaces from contact with cleaner.
3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.10 MASONRY WASTE DISPOSAL

A. 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. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 2613

SECTION 051200 - STRUCTURAL STEEL 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 work of this section.

1.2 SUMMARY

A. Section includes labor, materials, services, equipment, and appliances required in conjunction with or related to the furnishing, fabrication, delivery, and erection of all structural steel, as defined below. Include all supplementary parts, members, and connections necessary to complete the structural steel work, regardless of whether all such items specifically are shown or specified on the drawings.

1.3 REFERENCES

A. Definitions:

1. Shop Drawings: Drawings of the individual structural steel shipping pieces that are to be produced in the fabrication shop.

B. Reference Standards:

1. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified.

a. All federal (OSHA), state, and local laws that govern safety requirements for steel erection and other requirements if more stringent than the codes and standards enumerated below. OSHA requirements include regulation 29 CFG 1926, Part R, “Safety Standard for Steel Erection”.

b. AISC, “Steel Construction Manual.”

c. AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," except as noted herein.

1) Certain sections in this specification contain requirements that are more restrictive and/or different than contained in this standard. In such cases, the requirements of this specification shall control.

d. ANSI/AISC 360, Specification for Structural Steel Buildings; current edition.

e. ANSI/AWS D1.1, Structural Welding Code – Steel; current edition.

f. ANSI/AWS D1.3, Structural Welding Code – Sheet Steel; current edition.

g. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; current edition.

h. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; current edition.

i. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; current edition.

j. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; current edition.

k. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; current edition.

l. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; current edition.

m. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc; current edition.

n. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections; current edition.

o. The Society of Protective Coatings, "SSPC Painting Manual", Volumes 1 and 2.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Quality Control:

a. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

b. The Contractor shall coordinate the fabrication and erection of all structural steel work with the work of other trades.

c. The Fabricator alone shall be responsible for all errors of detailing, fabrication, and for the correct fitting of the structural members.

d. The Fabricator shall coordinate connection details, joint fit-up procedures, and field adjustment requirements with Erector. The Contractor shall coordinate provision of all erection bolts, lifting lugs, or other devices required for erection with the Fabricator and the Erector and for interference with architectural finishes and constraints.

2. Document Conflict and Precedence:

a. In case of conflict among documents, including architectural and structural drawings and specifications, notify Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.

b. Questions about Contract Documents: The Contractor shall notify promptly the Architect/Engineer whenever design of members and connections for any portion of the structure are not indicated clearly or when other questions exist about the Contract Documents. Such questions shall be resolved prior to the submission of shop drawings.

3. Materials and installed work may require testing and retesting, as directed by the governing building code or the Architect/Engineer, at any time during progress of work.

a. The Contractor shall provide adequate notification to the Owner's Testing Agency of construction operation including the project schedule to allow the Testing Agency to schedule inspections. Failure to notify sufficiently may result in additional costs incurred by the Testing Laboratory that may be back-charged to the Contractor by the Owner.

b. The Contractor shall cooperate with laboratory personnel, provide access to the work, and provide access to manufacturer's operations.

c. The Contractor shall cooperate with the Owner's Testing Laboratory when Arbitration Testing and Inspection is called for due to a disagreement regarding the tension in installed bolts that have been inspected according to the Testing and Inspection portion of this specification section.

d. The Contractor shall make adequate arrangement with the Owner's Testing Agency for inspection of material stockpiles and facilities.

e. The Contractor shall provide to the laboratory certificates and representative samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.

f. The Contractor shall furnish labor, equipment, and facilities as required for sampling and testing by the laboratory and other facilitates the required inspections and test.

g. Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents. Test not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See the Testing and Inspection portion of this specification section.

B. Alternates: Substitutions for the member sizes, type(s) of steel connection details, or any other modifications proposed will be considered by the Architect/Engineer only under the following conditions:

1. The request has been made and accepted prior to the submission of shop drawings. All substitutions shall be marked clearly and indicated on the shop drawings as a substitute.

2. There is a substantial cost advantage or time advantage to the Owner or that the proposed revision is necessary to obtain the required materials or methods at the proper times to accomplish the work in the time scheduled.

3. Sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by the Architect/Engineer, including cost reductions or savings in time to complete the work.

4. In no case shall such substitutions result in additional cost to the Owner.

1.5 SUBMITTALS

A. Product Data: Submit producer's or manufacturer's specifications and installation instructions to show compliance with specifications, including the specified standards):

Products:

1. Welding Electrodes.

2. Structural Steel Primer Paint.

3. Inorganic or Other Protective Paint.

B. Shop Drawings:

1. Detailed Shop Drawings: Submit drawings showing complete details and schedules for fabrication and assembly of structural steel members. Drawings shall include the following minimum information:

a. Details of cuts, connections, camber, holes, and other pertinent data.

b. Indication of welds by standard AWS symbols, and show size, length, and type of each weld.

c. Indication of type, size, and length of bolts, distinguishing between shop and field bolts. Identify the type of high-strength bolted connection (slip-critical, direct-tension, or bearing connections). Indicate locations of pretensioned bolts.

d. Connection material specification and sizes.

e. Holes, flange cuts, slots, and openings shall be made as required by the structural drawings, all of which shall be properly located by means of templates.

2. Erection Drawings: Submit complete erection drawings showing field installation and member-placing instructions for locating and attaching the individual shipping pieces.

3. All drawings submitted for review shall have blank space for a 2” high and 3.5” wide shop drawing stamp of the Engineer as part of the title block.

C. Certificates:

1. Structural Steel: Submit for each type.

2. High-Strength Bolts: Submit for each type, including nuts and washers.

3. Unfinished Bolts and Nuts.

D. Test and Evaluations Reports: Submit certified reports of tests required by this Specification. Include data on type(s) of tests conducted and test results.

1. For structural steel where is it unclear if the steel conforms to the ASTM requirements, submit certified test reports that verify conformity to ASTM standards.

E. Field Quality Control Submittals:

1. Surveys: Submit for each survey required.

F. Qualification Statements:

1. Submit qualification data, including required certifications, for firms and persons specified in the “Qualifications” section under Part 1, 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.

2. Submit a resume from the structural steel detailer showing a minimum of two years of experience selecting or completing structural steel connection details using information found in tables in the AISC “Steel Construction Manual”.

3. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints. Submit test reports showing successful passage of qualification tests for all non-prequalified WPSs.
4. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in the "Qualifications" section under Part 1. If recertification of welders is required, retesting will be at Contractor's responsibility.
5. A fabricator that is registered with the local building official and is approved to perform fabrication without special inspection shall submit a certificate of compliance stating that the work was performed in accordance with the approved construction documents.

1.6 QUALITY ASSURANCE

A. Scope of Work:
   1. Contract Obligations:
      a. Owner Responsibility: The Owner shall pay for initial shop and field inspections and tests as required during the fabrication and erection of the structural steel.
      b. Testing Laboratory Responsibility: The inspection by the Testing Laboratory of the Fabricator's work shall be in sequence, timely, and performed in such a manner so that corrections can be made without delaying the progress of the work. Inspections shall be performed by qualified technicians with a minimum of two years of experience in structural steel testing and inspection. Refer to "Qualifications of Welding Inspectors" Paragraph below. The Testing Laboratory shall provide test reports of inspections. All test reports shall indicate types and locations of defects found during inspection, the measures required and performed to correct such defects, statements of final approval of welding and bolting of shop and field connections, and other fabrication and erection data pertinent to the safe and proper welding and bolting of shop and field connections. Weld inspection reports shall be signed by an inspector with current certification as an AWS Certified Welding Inspector (CWI). In addition to the parties listed in this Specification the Fabricator and Erector shall receive copies of the test reports.
      c. Rejection of Material or Workmanship: The Owner, Architect, Engineer, and Testing Laboratory reserve the right to reject any material or workmanship not in conformance with the Contract Documents at any time during the progress of the work. However, this provision does not allow waiving the obligation for timely, in sequence inspections.

B. Testing Laboratory Requirements: The Owner's Testing Laboratory shall:
   1. Verify the fabrication shop's certification from AISC.
   2. Review field welder qualifications by certification or verify by retesting. Obtain welder certificates.

C. Qualifications:
   1. Fabricator:
      a. The structural steel fabricator shall have not less than 5 years of experience in the successful fabrication of structural steel similar to this project.

b. The structural steel fabricator must be registered and approved by the local building official to perform fabrication work without special inspection. Should the fabricator not be so approved, the fabricator shall reimburse the Owner for the cost of the special inspections required by the local building official.

2. Detailer:

a. The structural steel detailer shall have not less than 2 years of experience in the successful detailing of structural steel similar to this project including experience in selecting or completing structural steel connection details using information found in tables in the AISC "Steel Construction Manual.

3. Erector:

a. The structural steel erector shall have not less than 2 years of successful experience in the erection of structural steel of a similar nature to this project.

4. Welding Qualifications: Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code – Steel".

5. Independent Testing Laboratory:

a. Any testing laboratory retained to perform tests that are required by this specification shall meet the basic requirements of ASTM E 329 and shall submit to the Owner, Architect, and Engineer evidence of current accreditation from the American Association for Laboratory Accreditation, the AASTHO Accreditation Program or the "NIST" National Voluntary Laboratory Accreditation Program.

b. The Testing Laboratory shall be an Approved Agency by the Building Official to perform Special Inspections and other tests and inspections as outlined in the applicable building code.

c. Tests and inspections shall be conducted in accordance with specified requirements, and if not specified, in accordance with the applicable standards of the American Society for Testing and Materials or other recognized and accepted authorities in the field.

d. Qualification of Welding Inspectors:

1) Inspectors performing visual weld inspection shall meet the requirements of AWS D1.1 Section 6.1.4. Inspectors shall have current certification as an AWS Certified Welding Inspector (CWI). Assistant inspectors, if any, shall be supervised by an Inspector and shall be qualified by training and experience to perform the specific functions to which they are assigned.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. Do not store materials on structure in a manner that might exceed allowable loads on or cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed by Architect/Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel:

1. All hot rolled steel plates, shapes, sheet piling, and bars shall be new steel conforming to ASTM A 6.
2. Comply with the provisions of the following ASTM Specifications as appropriate for the grades and types, and at the locations as specified on the drawings:
    a. Structural Steel Wide Flange and WT Shapes: High Strength Steel, ASTM A 992.
    b. M-Shapes, S-Shapes, and Channels: Carbon Steel, ASTM A 36.
    c. Angle Shapes: Carbon Steel, ASTM A 36.
    d. Angle Shapes: High Strength Steel, ASTM A 572, Grade 50.
    e. Structural Steel Plates and Bars: Carbon Steel, ASTM A 36.

B. Structural Bolts and Threaded Fasteners: Structural bolts and threaded fasteners shall comply with the following ASTM Specifications as appropriate for the types and at the locations as specified on the drawings:

1. ASTM F 3125 Grade A325 Type 1.
2. ASTM F 3125 Grade A490 Type 1.
3. Threaded Round Stock:
    a. ASTM A 36.
    b. ASTM A 572 Grade 50 (to 2 inches in diameter).
4. Bolts and Nuts, High Strength Bolts: Bolts and nuts for all high strength bolts shall be heavy hex head conforming to ANSI Standards B18.2.1 and B18.2.2 respectively. Nuts shall conform to ASTM A 563.
5. Washers: All washers shall be circular, flat and smooth and shall conform to the requirements of Type A washers in ANSI Standard B23.1. Washers for high strength bolts shall be hardened and conform to ASTM F 436. Beveled washers for American Standard Beams and channels shall be square or rectangular, shall taper in thickness (16 2/3% slope) with an average thickness of 5/16". When an outer face of a bolted part has a slope greater than 1:20 with respect to a plane normal to the bolt axis, a beveled washer shall be used.
6. Zinc-Coated Bolts: ASTM F 3125 Grade A325 bolts, with their nuts and washers, that are used to connect steel called for on the drawings or in the specifications as hot-dip galvanized after fabrication shall be zinc-coated either by the hot-dip process in accordance with ASTM A 153, Class C or by the mechanical deposition process in accordance with ASTM B 695, Class 50, Type 1. The bolts, nuts, and washers shall all be zinc-coated using the same process and they shall be considered together as an assembly and shall be tested and shipped together as such. Comply with all the requirements of ASTM F 3125 Grade A325 and ASTM A 563 as they relate to zinc-coated materials. ASTM F 1852 bolts with their nuts, and washers shall be zinc-coated only by the mechanical deposition process in accordance with ASTM B 695, Class 50, Type 1. Do not zinc-coat ASTM F 3125 Grade A490 bolts.

7. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts will not be allowed.

8. New Bolts: All bolts shall be new and shall not be reused.

C. Electrodes for Welding:

1. Provide electrodes that comply with AWS D1.1, "Structural Welding Code - Steel" and that can produce welds that have a minimum Charpy V-notch toughness of 20 ft-lbs. at 70° F, unless noted otherwise in these specifications or on the drawings.

2. Electrodes for various welding processes shall be as specified below:

   a. SMAW:
      1) E70XX low hydrogen.

   b. SAW:
      1) F7X-EXXX.

   c. GMAW:
      1) ER70S-X.

   d. FCAW:
      1) E7XT-X.

3. Electrodes shall be compatible with parent metal joined.

D. Anchor Rods:

1. All anchor rods shall conform to ASTM F 1554. unless noted otherwise on the drawings and shall be of the yield strength as specified below as appropriate for the types and at the locations as specified on the drawings:

   a. Grade 55 (1/4 inch to 4 inches in diameter), complying with Supplementary Requirement S1 of ASTM F 1554.

2. Anchor rods used with galvanized baseplates shall be galvanized.

3. Nuts: All nuts with anchor rods shall be heavy hex head conforming to ASTM A 563.

4. Washers: Unless indicated otherwise, washers for all base plates shall be in accordance with the AISC “Steel Construction Manual”, Table 14-2 with holes 1/16” larger than the anchor rod diameter. Washers shall conform to ASTM A 36 steel.

E. Hot-Dip Galvanizing:

1. Scope: All structural steel items and their connections permanently exposed to exterior conditions or that are within areas of unconditioned airspace, whether specified on the drawings or not, shall be hot-dip galvanized after fabrication unless indicated on the drawings.

2. Zinc-coat all ASTM F 3125 Grade A325 bolts nuts, and washers used in the connection of such steel. Field welded connections shall have welds protected and the exposed portions of ASTM F3125 Grade A490 bolts, nuts, and washers shall be protected with galvanizing repair paint.

3. Surface Preparation: All steel to be hot-dip galvanized shall undergo the following surface preparation as specified by the Society for Protective Coatings (SSPC), Volume 2.

a. Remove all grease, oil, grime and foreign contaminants by thorough cleaning with an alkaline or organic solvent followed by thorough rinsing in cold water.

b. Remove scale by pickling in diluted sulfuric or hydrochloric acid. Pickling shall be followed by a rinse in warm water and a second rinse in cold water. As an alternative to pickling, the steel may be white metal blast cleaned according to SSPC-SP-5.

c. Dip in a flux solution of zinc ammonia chloride followed by drying at room temperature.

4. Zinc Coating:

The zinc coating for steel shapes and plates shall conform to ASTM A 123. Weight of zinc coating per square foot of surface for 1/8 inch and 3/16 inch thick steels shall average not less than 3.0 mils with no individual thickness less than 2.6 mils. The coating weight shall average not less than 3.9 mils for 1/4" thick and heavier steel with no individual thickness less than 3.3 mils.

F. Field Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20Type I - Inorganic, water-based, two component zinc-rich coating containing at least 93 percent metallic zinc by weight in dry film in accordance with ASTM D520, Type III. Product must have VOC content of 0 lbs./gal (0 g/L) in accordance with ASTM D3960 and comply with SCAQMD regulations for field application.

1. Product: ZRC Worldwide; ZRC ZERO VOC Water-Based Galvanizing Compound

2.2 FABRICATION

A. Structural steel members for which shop drawings have not been reviewed shall not be fabricated. Any steel detailed or fabricated prior to the Initial Survey from Part 3 below is at contractor's risk.

B. All fabricated material and connections shall fit within architectural constraints.

C. The omission from the shop drawings of any materials required by the Contract Documents shall not relieve the Contractor of the responsibility of furnishing and installing such materials, even though the shop drawings may have been reviewed.

D. Shop Fabrication and Assembly:

1. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specification and as indicated on approved final shop drawings. Provide camber in structural members where indicated.

2. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

3. Clearly mark the grade of steel on each piece, distinguishable in the field from floor surfaces, for purpose of field inspection and confirmation of grade of steel.

4. Fitted stiffeners shall be fabricated neatly between flanges, and the ends of stiffeners shall be milled or ground to secure an even bearing against abutting surfaces. All milled or ground joints shall bear throughout their contact length.

E. Dimensional Tolerances: Dimensional tolerances of fabricated structural steel shall conform to Section 6.4 of the AISC Code of Standard Practice.

F. Cutting: Manual oxygen cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is not within 1/8 inch of the finished dimension and final removal is completed by means such as chipping or grinding to produce a smooth surface quality free of notches or jagged edges. All corners shall be smooth and rounded to a minimum 1/2" radius.

G. Lifting and Erection Devices: The Fabricator shall be responsible for designing, detailing, and furnishing all lifting devices and erection aids required for erection. Such devices shall be removed after erection if they interfere with architectural finish requirements.

H. Drainage Holes: Provide 1 inch diameter drainage (weep) holes in all members (trusses, girders, beams, etc.) exposed to weather where rain water could collect (at low points and/or behind dams caused by connections, stiffener plates, etc.). Show all holes on shop drawings for review by the Engineer.

2.3 WELDING

A. Code: All shop and field welding shall conform to all requirements in the "Structural Welding Code – Steel", ANSI/AWS D1.1, as published by the American Welding Society (AWS).

B. Welder Certification: All shop and field welders shall be certified according to all the applicable AWS procedures for the welding process and welding position used. Each welder shall be assigned an identifying symbol or mark and all shop and field welded connections containing complete or partial joint penetration welds, multi-pass fillet welds, and fillet welds greater than 5/16” shall be identified by the symbol or mark of the welder responsible for the connection.

C. Minimum Size and Strength:

1. Fillet Welds: Minimum size of fillet welds shall be as specified in Table J2.4 in AISC Specification, Chapter J.
2. Partial-Penetration Groove Welds: The minimum effective throat thickness of partial-penetration groove welds shall be as specified in Table J2.1 in AISC Specification, Chapter J.
3. Minimum Strength of Welded Connections: Except as specified below in "Connections" or noted otherwise on the drawings, all shop and field welds shall develop the full tensile strength of the member or element joined. All members with moment connections as indicated on the drawings shall be welded to develop the full flexural capacity of the member, unless noted otherwise on the drawings.

D. Filler Metal Requirements: Weld metal shall be as specified in Table J2.5 in AISC Specification, Chapter J and other requirements of this specification.

E. Welding Procedure Specification:

1. All welding shall be performed in accordance with a Welding Procedure Specification (WPS) as required in AWS D1.1 and reviewed by the Owner’s Testing Laboratory and by the Architect/Engineer. The WPS variables shall be within the parameters established by the filler-metal manufacturer. Engage the services of an independent Testing Laboratory to provide the qualification testing required by AWS D 1.1, Chapter 4, part B to qualify any non-prequalified WPS needed for the project. The independent Testing Laboratory

shall prepare Welding Procedure Qualification Records (WPQR) documenting the successful qualification of each Welding Procedure Specification.

F. Welding Procedures:

1. All welding processes shall comply with the requirements of ANSI/AWS D1.1 unless noted otherwise.
2. Welds not specified shall, if possible, be continuous fillet welds developing the minimum strength, as specified above, using not less than the minimum fillet welds as specified by AISC.
3. The toughness and notch sensitivity of the steel shall be considered in the formation of all welding procedures to prevent brittle and premature fracture during fabrication and erection.
4. The Welding Procedure Specification shall be followed without deviation unless specific approval for change is obtained from the Owner's Testing Laboratory and the Architect/Engineer.
5. Before welding, particular attention shall be paid to surface preparation, fit up, and cleanliness of surfaces to be welded.
6. Minimum preheat and interpass temperatures for structural steel welding shall be as specified in ANSI/AWS D1.1, except that no welding shall be performed when the ambient temperature is lower than 0 degrees F. The temperature shall be measured from the side opposite that upon which the preheat is applied.
7. The heat, input, length of weld, and sequence of weld shall be controlled to prevent distortions. The surfaces to be welded and the filler metals to be used shall be subject to inspection before any welding is performed.
8. Welds shall be sound throughout. There shall be no crack in any weld or weld pass. Welds shall be considered sound if they conform to AWS requirements, as confirmed by non-destructive testing.
9. Welds shall be free from overlap.
10. Craters shall be filled to the full cross section of the welds.
11. For high-strength low-alloy steels, follow welding procedures as recommended by steel producer for exposed and concealed connections.
12. Fabricator and Erector shall coordinate welding responsibility at all welded joints.

G. Stress Relieving: All welding sequences shall be such as to reduce the residual stresses due to welding to a minimum value. If high residual stresses are present, stress relieving of joints shall be required. Welded connections shall be detailed and designed to minimize the accumulation and concentration of through-thickness strains due to weld shrinkage.

2.4 BOLTING

A. Connection Type: Unless noted otherwise on the drawings, all bolted connections shall be snug-tightened using high-strength bolts in standard holes (hole diameter nominally 1/16 inch greater than the nominal bolt diameter) with threads included in the shear planes. Notwithstanding, the contractor shall be responsible to adhere to provisions of

ANSI/AISC 360 Section J1.10, which lists circumstances under which certain connections require pretensioned high strength bolts.

B. Oversize, Short-Slotted and Long-Slotted Holes: The dimensions and washer requirements of oversize, short-slotted, and long-slotted holes shall conform to ANSI/AISC 360 Table J3.3.

C. Fastener Tension:

1. High strength bolts in snug-tightened joints shall be tightened to a snug tight condition only. Do not pretension bolts in snug-tightened joints the same as if they were in slip-critical joints. The snug-tightened condition is defined as the tightness that exists when all plies are in firm contact. This may usually be attained by a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench. If Twist-Off-Type Tension-Control Bolt Assemblies are used in snug-tightened joints, do not fully tension bolts and leave the splines intact.

D. Washers: Washers under the bolt head and/or nut shall be used as required by the RCSC Specification.

E. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts are not allowed.

F. Impact Wrenches: Properly sized and lubricated air impact wrenches with adequate air pressure shall be utilized for all bolt installation.

G. New Bolts: All bolts shall be new and shall not be reused.

2.5 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. Specification: Surface preparation, paint, and painting practices shall conform to the "SSPC Painting Manual", Volumes 1 and 2.

B. Scope: All steel shall remain unpainted, except the following:

1. Shop paint surfaces that are to remain exposed to view in the final construction.
2. Shop paint any steel other than weathering steel that, in the final construction, will not be in a controlled environment and is therefore subject to moisture or high humidity infiltration and that has not been specified to be galvanized.
3. Coordinate all shop painting of structural steel with Architect's painting requirements as specified on the architectural drawings and in the specifications. The Fabricator shall be responsible for determining all painting requirements (which surfaces are to be painted or left unpainted) on the project prior to fabrication.

C. Additional Painting Requirements:

1. Extend shop paint to 2" from location of welds on surfaces that are to be field welded.
2. All unpainted mating surfaces of all elements that are welded together into an assembly that is permanently exposed to the exterior shall be seal welded in addition to structural welding requirements.
3. If individual elements (including the mating surfaces) of an assembly that is required to be painted are painted prior to welding into an assembly, then all painted surfaces affected by

welding shall be touched-up and repaired (according to manufacturer's instructions, if any) to prevent corrosion bleeding.

4. The fabricator shall be responsible to ensure that all elements of all assemblies that are to be painted are fabricated so that no exposed surface shall be subject to stains due to corrosion bleeding during the warranty period of the paint.

D. Surface Preparation – Unpainted Steel: All structural steel that is not specified to receive a shop coat of primer paint shall be prepared in accordance with Society for Protective Coatings specifications as follows:

1. SSPC-SP 2, "Hand Tool Cleaning" or SSPC-SP 3, "Power Tool Cleaning" unless otherwise specified.

2. SSPC-SP 6, "Commercial Blast Cleaning" shall be applied to the faying surfaces of connections that are noted on the drawings as slip-critical connections requiring a Class B surface. Apply this surface preparation to the area surrounding all bolt holes including the area up to 2" outside the outer-most holes.

E. Surface Preparation and Primer Paint – Shop Painted Steel:

1. Surface Preparation: Prepare the surface of all structural steel specified to be shop painted as required by the paint manufacturer or the Society for Protective Coatings specifications, but not less than the following:

a. SSPC-SP 2, "Hand Tool Cleaning" or SSPC-SP 3, "Power Tool Cleaning" unless otherwise specified.

b. SSPC-SP 6, "Commercial Blast Cleaning" shall be applied to the faying surfaces (including filler and member-end supplement plates, if any) of connections that are noted on the drawings as requiring a slip-critical coating. At a minimum, apply this surface preparation to the area between and surrounding all bolt holes including the area up to 2" outside the outer-most holes.

2. Priming: Immediately after surface preparation, apply primer to all structural steel specified to be shop primed in strict accordance with manufacturer's instructions and the Society for Protective Coatings specifications. Apply paint at a rate to conform to the manufacturer's written instructions and to provide a dry film thickness of not less the 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, welds, and all exposed surfaces. Apply two coats to surfaces that are inaccessible after assembly or erection. Change the color of the second coat to distinguish it from the first coat.

3. Finish Coat: Coordinate shop primer paint requirements with architectural drawings and specifications. The primer selected must be compatible with any specified finish coat.

F. Shop Touch-Up Painting: The Fabricator shall provide for cleaning and touch-up painting of welds, bolted connections (including nuts, bolts, washers, filler plates, member end supplement plates and welds, if any), and abraded areas. Prior to shipment, apply paint to exposed areas using same materials and surface preparation as used for shop painting. Paint shall be applied by brush or spray with minimum dry film thickness of 1.5 mils.

2.6 SOURCE QUALITY CONTROL

A. The Testing Laboratory shall provide the following tests at the designated fabrication shops:

1. Test welds completed in the shop according to “Weld Testing” Paragraph below.
2. Test bolted connections completed in the shop according to “High-Strength Bolt Testing” Paragraph below.

B. Source Inspection: The Testing Laboratory shall provide the following inspections at the designated fabrication shops:

1. Shop Inspection Waiver: The requirement to perform fabricating shop inspections may be waived if the Fabricator produces evidence from the Building Official of being a registered, approved fabricating shop and if allowed by the Engineer. If these are waived, then the inspection, testing, and reporting requirements of the Owner's Testing Laboratory shall be transferred to the Fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspection Prior to Erection: Erector shall examine areas and conditions under which structural steel work is to be installed and notify the Contractor and the Architect/Engineer in writing of conditions detrimental to proper and timely completion of the work.

3.2 PREPARATION

3.3 ERECTION

A. The erection work shall comply with the requirements of AISC Specification Section M4.

B. Anchor Rods: Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout. Use only steel wedges or shims.

C. Field Assembly of Structural Steel:

1. Provide temporary planking and working platforms as necessary to effectively complete work.
2. Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Level and plumb individual members of structure within specified AISC tolerances. The Contractor shall coordinate with Erector and Fabricator regarding possible discrepancies in member lengths between temperature at time of fabrication and temperatures during erection, and shall make necessary adjustments to ensure plumbness within AISC tolerances at 70°F. Compensate for cumulative welding draw, construction loadings, sequential applications of dead loads, or any other predictable conditions that could cause distortions to exceed tolerance limitations.
3. On welded construction exposed to view or weather, remove erection bolts, fill holes with plug welds or filler and grind smooth at exposed surfaces.
4. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces receiving field welds.

5. Comply with all bolting and welding requirements of Part 2 of this specification.

D. Field Modifications to Structural Steel: Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and structural fitting of parts shall be reported immediately to the Architect/Engineer, and approval of the method of correction shall be obtained. Approved corrections shall be made at no additional cost to the Owner. Do not use cutting torches, reamers, or other devices in the field for unauthorized correction of fabrication errors.

E. Miscellaneous Framing: Provide supplemental structural steel support framing for steel deck where columns, or other framing members or floor openings interrupt normal deck bearing whether shown or not on the architectural, mechanical, or structural drawings.

F. Removal of Erection Aids and Devices: The Erector shall remove all erection aids and devices that interfere with architectural finish or MEP requirements.

G. Field Touch-Up Painting:

1. Clean field welds, unpainted areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates, and welds), and any shop painted areas that are abraded. Apply paint to all exposed areas using same material and surface preparation as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

2. Clean field welds, ungalvanized areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates, and welds), and any galvanized areas that are abraded. Prepare surfaces and apply two coats of the specified galvanizing repair paint in accordance with ASTM A 780.

3. The Contractor shall ensure that, at the substantial completion of the project, all structural steel, bolted and/or welded, required to be painted shall have all necessary steel surfaces painted (including touch-up painting as required) to prevent corrosion bleeding.

H. Clean Up: Clean up all debris caused by the Work of this Section, keeping the premises neat and clean at all times.

3.4 FIELD QUALITY CONTROL

A. Field Testing: The Testing Laboratory shall provide the following tests in the field:

1. Test welds completed in the field according to “Weld Testing” Paragraph below.

2. Test bolted connections completed in the field according to “High-Strength Bolt Testing” Paragraph below.

B. Field Inspection: The Testing Laboratory shall provide the following inspections in the field:

1. Inspect galvanized HSS and other cold-worked structural steel members for cracking or other damage resulting from galvanizing process. Endeavor to complete inspections prior to erection of these members. Immediately notify Contractor and Architect/Engineer of any irregularities discovered.

2. Provide continuous or periodic monitoring of field welding as described in “Weld Inspection and Process Monitoring” Paragraph below.

3. Inspect welded or bolted connections that were completed, but not inspected, in the shop. Perform inspections according to "Weld Inspection and Process Monitoring" Paragraph below and/or "High-Strength Bolt Inspection and Process Monitoring" Paragraph below as appropriate.
4. Obtain the planned erection procedure, and review with the Erector's supervisory personnel.
5. Check structural steel as received in the field for possible shipping damage, workmanship, and identification marking to conform to AISC 360 for structural steel and specified ASTM standards for other steel.
6. Endeavor to guard the Owner against the Contractor cutting, grinding, reaming, or making any other field modification to structural steel without the prior approval of the Engineer. Report any noted unauthorized modifications to the Owner and Engineer.

C. Weld Inspection and Process Monitoring: The Testing Laboratory shall make the following inspections of the welds and welding processes. Welds performed in the fabricating shop may be inspected in the field unless continuous monitoring of the welding process is herein specified or if access in the field due to other work or shop finishes makes field inspection impractical:
1. Approve Welding Procedure Specifications submitted by the Contractor. Approve any changes submitted by the Contractor to any WPS that has already been approved. Obtain the Welding Procedure Qualification Record (WPQR) for each successful WPS qualification.
2. Periodically verify welding electrodes to be used and other welding consumables as the job progresses.
3. Periodically observe joint preparation, assembly practice, welding techniques including preheating and sequence, and the performance of welders with sufficient frequency to assure compliance with code and contract document requirements. Check preheating to assure conformance with AWS D1.1, Section 5.6. Verify procedure for control of distortion and shrinkage stresses.
4. Continuously observe joint preparation and fit up, backing strips, and runout plates for welded moment connections and column splices.
5. Visually inspect 100 % of welds for proper size, length, location, and weld quality in accordance with AWS D1.1 requirements. Unless specifically noted otherwise, all welding shall be considered statically loaded nontubular connections.
6. Visually inspect 100% of completed shear connectors on each beam.
7. In addition to the inspections above, perform the following:
    a. Continuously monitor and observe joint preparation, assembly practice, welding techniques including preheating and sequence, and the performance of welders for 100% of complete and partial joint penetration welds, plug and slot welds, multiple-pass fillet welds, and single-pass fillet welds greater than 5/16 inch. Check preheating to assure conformance with AWS D1.1, Section 5.6. Verify procedure for control of distortion and shrinkage stresses.
    b. Periodically monitor welding of single-pass fillet welds that are less than or equal to 5/16 inch.

D. Weld Testing:

1. Perform nondestructive examination services using a qualified technician with the necessary equipment to perform the following:
    a. Nondestructive examination conducted in accordance with the specific requirements for the item being examined including radiographic (RT), ultrasonic (UT), magnetic particle (MT), or dye-penetrant inspection (PT). Nondestructive inspection procedures shall conform to AWS D1.1.
    b. Interpret, record, and report results of the nondestructive tests.
    c. Mark for repair, any area not meeting Specification requirements. Correction of rejected welds shall be made in accordance with AWS D1.1.
    d. Re-examine repair areas and interpret, record, and report the results of examinations of repair welds.
    e. Verify that quality of welds meets the requirements of AWS D1.1.
2. Fillet Welds: Provide the following:
    a. MT test a minimum of 10% of the length of each fillet weld exceeding 5/16".
    b. Periodic MT testing of representative fillet welds 5/16" and less but need not exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph.
    c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds.
3. Partial Joint Penetration (PJP) Welds, including Flare-Bevel Groove Welds: Provide the following:
    a. MT test a minimum of 25% of the length of each PJP weld exceeding 5/16" effective throat.
    b. Periodic MT testing of representative PJP welds 5/16” and less but need not exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph.
    c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds.
4. Complete Joint Penetration (CJP) Welds: Provide the following:
    a. All CJP welds equal to or exceeding 5/16" thickness shall be 100% UT tested per AWS D1.1 Clause 6 Part F. The Testing Laboratory shall review the CJP joints to determine where geometry or accessibility precludes the use of standard scanning patterns per AWS D1.1 Clause 6 Part F. At these locations the testing laboratory shall develop and submit for approval a written testing procedure in accordance with AWS D1.1 Annex S.
    b. Periodic MT testing of representative CJP welds 5/16” and less not to exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph.
    c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds.
5. Acceptance Criteria:

a. Visual, MT, PT shall be per AWS D1.1 Table 6.1.

b. UT testing shall be per AWS D1.1 6.13.1 and Table 6.2.

6. The costs of repairing defective welds and the costs of retesting by the Testing Laboratory providing services for the Owner shall be borne by the Contractor. If removal of a backing strip is required by the Testing Laboratory to investigate a suspected weld defect, such cost shall be borne by the Contractor.

E. High-Strength Bolt Inspection and Process Monitoring: The Testing Laboratory shall perform the following inspections for connections joined with high-strength bolts. Bolting performed in the shop may be inspected in the field unless continuous monitoring of the bolting operation is specified herein:

1. Check daily the calibration of impact wrenches used in field bolted connections.

2. Monitoring of Bolting Installation:

a. Periodic Monitoring: All joint types and bolt installation methods shall be monitored on a periodic basis.

END OF SECTION - 051200

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. Metal ladders.

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 04 2010 "Reinforced Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

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. Shop Drawings: Show 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. Metal ladders.

C. Delegated-Design Submittal: For 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.

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 01 4000 "Quality Requirements," to design ladders.

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. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

E. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

F. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 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.
3. Provide stainless-steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

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. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.

D. 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 1 (A1).

E. 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.

F. 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.

G. 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.

H. Post-Installed Anchors: chemical anchors.
1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) [Group 2 (A4)] stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

I. 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. 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.

B. 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.

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.

2.6 METAL LADDERS

A. General:

1. Comply with ANSI A14.3..

B. Steel Ladders:

1. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch (9.5-by-64-mm) steel flat bars, with eased edges.
3. Rungs: 3/4-inch- (19-mm-) diameter steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. 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.
6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Harsco Industrial IKG, a division of Harsco Corporation; Mebac.
        2) SlipNOT Metal Safety Flooring, a division of W. S. Molnar Company; SlipNOT.

7. 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.
8. Support each ladder at top and bottom and not more than 48 inches (1500 mm) o.c. with welded or bolted steel brackets.
9. Galvanize and prime exterior ladders, including brackets.
10. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.

2.7 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.

2.8 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 unless indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast 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.

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 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 09 9123 "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 061000 - 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. This Section includes the following:
   1. Rooftop equipment bases and support curbs.
   2. Miscellaneous lumber.
   3. Wood blocking, cants, and nailers.
   4. Wood furring.

1.3 DEFINITIONS

A. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   1. NELMA - Northeastern Lumber Manufacturers Association.
   2. NLGA - National Lumber Grades Authority.
   3. SPIB - Southern Pine Inspection Bureau.
   4. WCLIB - West Coast Lumber Inspection Bureau.
   5. WWPA - Western Wood Products Association.

1.4 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, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.
   3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. Provide air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   3. Provide dressed lumber, S4S, unless otherwise indicated.
   4. Provide dry lumber with 15 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness, unless otherwise indicated.

B. Miscellaneous Plywood Panels:
   1. Plywood: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated.
   2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.
   3. Factory mark panels according to indicated standard.

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 Chemical Options: Chemicals used shall be acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry material after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   3. Wood framing members that are less than 18 inches above grade.
   4. Wood floor plates that are installed over concrete slabs directly in contact with earth.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, provide materials that 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: 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 beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials are to 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 location and where indicated.
2. Interior Type A: Treated materials are to 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.

C. Application: Treat all rough carpentry unless otherwise indicated.

2.4 DIMENSION LUMBER

A. General: Provide dimension lumber of grades indicated according to the American Lumber Standards Committee National Grading Rule provisions of the grading agency indicated.

B. Non-Load-Bearing Interior Partitions: Construction, Stud, or No. 2 grade and any of the following species:
1. Southern pine or mixed southern pine; SPIB.
2. Eastern softwoods; NELMA.
3. Northern species; NLGA.
4. Western woods; WCLIB or WWPA.

C. Framing other than non-load-bearing partitions by Grade: Construction or No. 2 grade and any of the following species:
1. Douglas fir-larch; WCLIB or WWPA.
2. Douglas fir-south; WWPA.
3. Douglas fir-larch (north); NLGA.
4. Hem-fir; WCLIB or WWPA.
5. Hem-fir (north); NLGA.
6. Southern pine; SPIB.
7. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
8. Spruce-pine-fir; NLGA.

2.5 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction, including the following:
1. Rooftop equipment bases and support curbs.
2. Blocking.
3. Cants.
4. Nailers.
5. Furring.
6. Grounds.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 15 percent maximum moisture content and the following species:
1. Mixed southern pine; SPIB.
2. Hem-fir or Hem-fir (north); NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or Spruce-pine-fir; NELMA, NLGA, WCLIB, or WWPA.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine, No. 2 grade; SPIB.
2. Eastern softwoods; No. 2 Common grade; NeLMA.
3. Northern species; No. 2 Common grade; NLGA

4. Western woods; Construction or Not. 2 common grade; WCLIB or WWPA.

2.6 PANEL PRODUCTS

A. Miscellaneous Concealed Plywood: Exterior sheathing, span rating to suit framing in each location, and thickness as indicated but not less than 1/2 inch.

B. Plywood Underlayment: DOC PS 1, Exterior A-C with fully sanded face, thickness as indicated but not less than 1/2 inch.

C. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch thick.

2.7 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture. Provide nails or screw, in sufficient length. To penetrate not less than 1-1/2 inches in to wood substrate.
   1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/ A 153M.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction based on ICC-ES-AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01.

2.8 METAL FRAMING ANCHORS

A. Allowable design loads, as published by manufacturer, are to meet or exceed those indicated

B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Discard units of material with defects that impair the quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

C. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

D. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

E. Where wood-preservative treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

F. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.

G. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.

H. Use fasteners of appropriate type and length. Pre-drill members when necessary to avoid splitting wood.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

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 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
   1. Fire block furred spaces of walls, at each floor level and at ceiling, with wood blocking or noncombustible materials accurately fitted to close furred spaces.

B. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.4 PANEL PRODUCT INSTALLATION

A. Plywood Panels: Comply with applicable recommendations contained in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial," for types of plywood panels and applications indicated.

END OF SECTION 061000

SECTION 070150.19 - PREPARATION FOR REROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Partial tear-off [of roof areas indicated on Drawings].
   2. Re-cover preparation [of roof areas indicated on Drawings].
   3. Removal of flashings and counterflashings as needed for partial reroof.

1.2 UNIT PRICES

A. Work of this Section is affected by [insulation removal and replacement unit price] and [roof sheathing removal and replacement unit price]. Refer to Division 1, Section “Unit Prices”.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting removal Work, conduct conference at project site, time to be determined.

1.4 INFORMATIONAL SUBMITTALS

A. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations.

   1. Submit before Work begins.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Approved by warrantor of existing roofing system to work on existing roofing.

1.6 FIELD CONDITIONS

A. Existing Roofing Systems: [SBS-modified bituminous] and [TPO] roofing.

B. Owner [will not] occupy portions of building immediately below reroofing area.

   1. Provide Owner with not less than [72] seventy-two hours' written notice of activities that may affect Owner's operations.
   2. Coordinate work activities daily with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.

3. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below affected area.

    a. Verify that occupants below work area have been evacuated before proceeding with work over impaired deck area.

C. Protect building to be reroofed, adjacent buildings, walkways, site improvements and landscaping from damage or soiling from reroofing operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

E. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.
1. Construction Drawings [and Project Manual] for existing roofing systems are provided for Contractor's convenience and information, but they are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations. Contractor is responsible for conclusions derived from existing documents.

F. Coordinate with structural engineer for construction load limits on existing roof areas to remain, and existing roof areas scheduled to be reroofed for rooftop equipment wheel loads for uniformly distributed loads.

G. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1. Remove only as much roofing in one day as can be made watertight in the same day.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty issued by:
1. Housing Unit K (Building 5)
    a. Manufacturer: Johns Manville
    b. 20-year warranty began 11/19/2012 (still under warranty)
    c. SBS Modified Bitumen
2. Housing Units L (Building 6) and M (Building 7)
    a. Manufacturer: Versico
    b. 20-year Manufacturer began 1/14/2016 (still under warranty)
    c. White TPO membrane

PART 2 - PRODUCTS

2.1 AUXILIARY REROOFING MATERIALS

A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing roofing system.

PART 3 - EXECUTION

3.1 PREPARATION

A. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.

B. Shut off rooftop utilities and service piping before beginning the Work.

C. Test existing roof drains to verify that they are not blocked or restricted.

1. Immediately notify Engineer of any blockages or restrictions.

D. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work.

1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

E. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

F. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.

1. Prevent debris from entering or blocking roof drains and conductors.

a. Use roof-drain plugs specifically designed for this purpose.
b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.

a. Do not permit water to enter into or under existing roofing system components that are to remain.

3.2 ROOF TEAR-OFF

A. Lower removed roofing materials to ground and onto lower roof levels, using dust-tight chutes or other acceptable means of removing materials from roof areas.

1. Remove partial [roof insulation] [and] [cover board] as needed to install new roof top equipment and to slope roof for drainage around new equipment.

a. Remove unadhered bitumen, unadhered felts, and wet felts.

2. Remove excess asphalt from steel deck.

a. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.

3. Remove fasteners from deck [or cut fasteners off slightly above deck surface].

B. Partial Roof Tear-off: [Where indicated on Drawings, remove] existing roofing down to [existing insulation] and immediately check for presence of moisture.

1. [Engage] a qualified testing agency to perform the following test:

2. Survey exposed substrate that is to remain using infrared color thermography according to ASTM C1153.

   a. Prepare survey report of initial scan indicating locations of entrapped moisture, if any, and area calculations of locations of entrapped moisture.

3. Remove wet or damp materials below existing roofing.

   a. [Removal is paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.]

4. Inspect wood blocking, curbs, and nailers for deterioration and damage.

   a. If wood blocking, curbs, or nailers have deteriorated, immediately notify Engineer.
   b. [Removal is paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.]

5. Remove excess asphalt from steel deck that is exposed by removal of wet or damp materials.

   a. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.

6. Remove fasteners from deck [or cut fasteners off slightly above deck surface].

3.3 DECK PREPARATION

A. Inspect deck after tear-off of roofing system.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Engineer.

1. Do not proceed with installation until directed by Engineer.

C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Engineer.

1. Do not proceed with installation until directed by Engineer.

3.4 ROOF RE-COVER PREPARATION

A. Remove blisters, ridges, buckles, [mechanically attached roofing fastener buttons projecting above roofing,] and other substrate irregularities from existing roofing that inhibit new recover boards from conforming to substrate.

1. Verify that existing substrate is dry.

2. Remove materials that are wet or damp.

a. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.

3.5 BASE FLASHING REMOVAL

A. Inspect parapet sheathing, wood blocking, curbs, and nailers for deterioration and damage.

1. If parapet sheathing, wood blocking, curbs, or nailers have deteriorated, immediately notify Engineer.

END OF SECTION 070150.19

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. This Section includes the following:
   1. Concealed building insulation.
      a. Board (rigid) type.

B. Related Sections include the following:
   1. Division 7 for insulation specified as part of roofing construction.
   2. Division 15 Section for mechanical systems insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulation products.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface-Burning Characteristics: ASTM E 84.
   2. Fire-Resistance Ratings: ASTM E 119.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by 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 plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.

3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Extruded-Polystyrene Board Insulation:
      a. DiversiFoam Products
      b. Dow Chemical Company
      c. Owens Corning
      d. ACH Foam Technologies LLS
   2. Polyisocyanurate Board Insulation:
      a.
      b. GAF
      c. BASF
      d. Celotex Corporation.
      e. Johns Manville Corporation.
   3. Glass-Fiber Insulation:
      a. CertainTeed Corporation
      b. Johns Manville Corporation
      c. Knauf Fiber Glass
      d. Owens Corning

2.2 INSULATING MATERIALS

A. General: Provide insulating materials that comply with requirements and with referenced standards.

   1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.

B. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indices of 75 and 450, respectively:

   1. Type IV, 1.60 lb/cu. ft., unless otherwise indicated.

C. Un-faced Mineral-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.

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

3.2 PREPARATION

A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF CAVITY WALL INSULATION

A. On units of plastic insulation, install small pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, as recommended by manufacturer. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

3.5 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (non-breathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

3.6 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072726 - AIR AND VAPOR BARRIER

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section includes, but is not limited to, the following:
   1. Materials and installation methods for fluid applied air and vapor barrier membrane system located in the non-accessible part of the wall.
   2. Materials and installation methods to bridge and seal air leakage pathways in roof and foundation junctions, window and door openings, control and expansion joints, masonry ties, piping and other penetrations through the wall assembly.

B. Related Sections: Other specification sections that directly relate to the works of this section include, but are not limited to, the following:
   1. Division 04 Section "Unit Masonry"
   2. Division 07 for Roof Membrane
   3. Division 07 Section "Sheet Metal Flashing and Trim
   4. Division 07 Section "Joint Sealants"

1.2 PERFORMANCE REQUIREMENTS

A. Provide an air and vapor barrier system to perform as a continuous barrier to air infiltration/exfiltration and water vapor transmission and to act as a liquid water drainage plane flashed to discharge any incidental condensation or water penetration.

1.3 REFERENCES

A. The following standards and publications are applicable to the extent referenced in the text. The most recent version of these standards is implied unless otherwise stated.

B. American Society for Testing and Materials (ASTM)
   1. C 836 - Standard Specification for High Solids, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
   2. D 412-87 - Standard Test Methods for Rubber Properties in Tension
   3. D 903-83 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
   4. D 1644-93 - Test Methods for Non-volatile Content of Varnishes
   5. D 1970-94 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
   6. D 4541-02 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
   7. D 3767-92 - Standard Practice for Rubber - Measurements of Dimensions
   8. E 96-95 - Test Methods for Water Vapor Transmission of Materials
   9. E 2178-01 - Standard Test Method for Air Permeance of Building Materials
   10. E 283-91 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

1.4 ACTION SUBMITTALS

A. Product Data: Submit manufacturer’s product data, installation instructions, use limitations and substrate preparation recommendations.

B. Shop drawings showing locations and extent of air and vapor barrier system including details for terminations flashings, penetrations, window and door openings and treatment of substrate joints and cracks.

C. Written documentation demonstrating installer's qualifications under the "Quality Assurance" article including reference projects of a similar scope.

D. Samples: Submit representative samples of the following for approval:
   1. Fluid applied membrane
   2. Transition tape
   3. Through Wall Flashing

E. Warranty: Submit a sample warranty identifying the terms and conditions stated below.

1.5 QUALITY ASSURANCE

A. Manufacturer: Air and vapor barrier systems shall be manufactured and marketed by a firm with a minimum of 20 years' experience in the production and sales of waterproofing. Manufacturers proposed for use, but not named in these specifications, shall submit evidence of ability to meet all requirements specified and include a list of projects of similar design and complexity completed within the past five years.

B. Installer: The installer shall demonstrate qualifications to perform the work of this Section by submitting the following:

   1. List of at least three (3) projects contracted within the past five (5) years of similar scope and complexity to this project carried out by the firm and site supervisor.
   2. Installer must show evidence of adequate equipment and trained field personnel to successfully complete the project in a timely manner.

C. Materials: Fluid applied air and vapor barrier material shall be two-part synthetic rubber-based systems free of solvents, isocyanates and bitumen. For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include but not be limited to the following:
   1. Review of submittals.
   2. Review of surface preparation, minimum curing period and installation procedures.
   3. Review of special details and flashings.
   4. Sequence of construction, responsibilities and schedule for subsequent operations.
   5. Review of mock-up requirements.
   6. Review of inspection, testing, protection and repair procedures.

E. Inspection and Testing: Cooperate and coordinate with the Owner's inspection and testing agency. Do not cover any installed air and vapor barrier membrane until it has been inspected, tested and approved.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

B. Do not double-stack pallets of fluid applied membrane components on the job site. Provide cover on top and all sides, allowing for adequate ventilation.

C. Protect fluid-applied membrane components from freezing and extreme heat.

D. Sequence deliveries to avoid delays, but minimize on-site storage.

1.7 PROJECT CONDITIONS

A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive the air and vapor barrier membrane.

1.8 WARRANTY

A. Submit manufacturer's warranty that air and vapor barrier and accessories are free of defects at time of delivery and are manufactured to meet manufacturer's published physical properties and material specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

2.2 FLUID APPLIED MEMBRANES

A. Fluid-Applied, Vapor Permeable Membrane Air Barrier: Synthetic polymer membrane.
   1. Subject to compliance with requirements, provide products by one of the following:
      a. Carlisle Coatings & Waterproofing (CCW); Barritech VP.
      b. Grace; Perm-A-Barrier VP.
      c. Henry; Air Bloc 33.
   2. Physical and Performance Properties:
      a. Air Permeance: Maximum (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E2178.
      b. Vapor Permeance: Minimum 10 perms, ASTM E96M.
      c. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.

2.3 AIR BARRIER ACCESSORY MATERIALS

A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.

B. Transition Strip: Butyl based, fire resistant, 40 mil thick self-adhering sheet consisting of 30 mil of butyl adhesive 10-mil thick, cross-laminated polyester coating, and a polyethylene film with release liner backing.

C. Primer: Quick-drying, solvent based high tack adhesive.

D. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The installer shall examine the conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 AIR BARRIER SURFACE PREPARATION

A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Review the repairs made by others in preparation for the air barrier installation.

D. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

3.3 AIR BARRIER DETAIL INSTALLATION

A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity and compatibility of air barrier with roofing membrane.
2. Install butyl transition strip on the top of the parapet wall from the inside of the wall to the outside wall and continue down the outside wall a minimum of 3 inches.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fish mouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.4 TRANSITION STRIP INSTALLATION

A. Install strips, transition strips, and auxiliary materials according to air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install butyl strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over both substrates.

B. Apply transition strip over cured air membrane overlapping 3 inches onto each surface according to air barrier manufacturer's written instructions.

C. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and 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. Apply strip and transition strip onto each surface overlapping 3 inches onto each surface according to air-barrier manufacturer's written instructions.

C. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Overlap transition strips a minimum of 3 inches. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
   1. Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil applied in one coat.

D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

END OF SECTION 072726

SECTION 075216 – HYBRID MODIFIED BITUMEN MEMBRANE ROOF SYSTEM

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 the following:

1. Hybrid Modified Bitumen Membrane Roofing.
2. Roof insulation.
3. Coverboard

B. Unit Prices: Refer to Division 1 Section "Unit Prices" for description of Work in this Section affected by unit prices.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.

1. Fire/Windstorm Classification: Class 1A-90, 72 MPH peak wind speed.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Sheathing Paper
2. Coated Heavy-Weight Base
3. Primer

4. Fasteners
5. Asphalt
6. Asphalt Roofing Cement
7. Insulation
8. Coverboard
9. SBS Base Sheet
10. Type IV Interplies
11. SBS Cap Sheet (Hot-Applied)
12. SBS Cap Sheet Adhesive
13. Modified Flashing Plies
14. Sealants and Mastic

B. System Spec Plate: Submit a manufacturer's assembly spec plate depicting the ordering and attachment of the materials in the system.

1. Included with the spec plate, provide a narrative of the assembly including the application and attachment methods.
2. Narrative must include all system components from the deck up through the cap sheet.
3. Include manufacturer's system spec number for roof system.

C. Shop Drawings: For tapered insulation layout and system details. Include plans, elevations, sections, details, and attachments as required to fully describe layout and details.

1. Base flashings, cants, and membrane terminations.
2. Tapered insulation, including slopes.
3. Crickets, saddles, and tapered edge strips, including slopes.
4. Insulation fastening patterns.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Upon request, submit evidence of meeting performance requirements.

F. Qualification Data: For the firm and persons completing the work.

1. Include lists of completed projects with the project names and addresses, names and addresses of architects and owners.

G. Maintenance Data: For roofing system to include in maintenance manuals.

H. Warranties: Special warranties specified in this Section.

I. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: 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 warranty.

1. Installer must have a minimum of three (3) years experience installing the roof system specified.
2. Job Site Superintendent must have a minimum of five (5) years experience in roofing.

B. Manufacturer Qualifications: A qualified manufacturer that has UL listing and FMG approval for a roofing system identical to the system specified for this Project.

C. Source Limitations: Obtain components for roofing system from or approved by the roofing system manufacturer.

D. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

E. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with Owner, Engineer, Architect, roofing Installer, roofing system manufacturer's representative, 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 will affect 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.

1.7 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, and directions for storage.

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.

1. Store inside or covered with waterproof tarps to protect all pieces from any precipitation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Manufacturer’s Warranty: Manufacturer's form, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Special warranty includes roofing membrane, base flashings, roofing membrane accessories roof insulation fasteners cover boards walkway products and other components of roofing system.
2. Warranties that allow for arbitration are not acceptable.
3. Indicate by letter that “All roofing components exclusive of the deck are approved and compatible with the warranty requirements of the roof system as specified, and that the warranty specified will be issued at completion of the project if system is installed as designed.”
4. Warranty Period Requested: Fifteen (15) years from date of Substantial Completion.
5. Owner reserves the right to purchase a Twenty (20) year warranty for all of the roofs covered under the scope of work, up through the substantial completion of the project.

B. Installers Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including all components of roofing system such as roofing membrane, ply sheets, base sheets, base flashing, roof insulation, fasteners, cover boards, and walkway products, for the following warranty period:

1. The liability of the Surety Company under the installer warranty provisions of this contract is limited to correcting defective workmanship and materials for a period of two years from the substantial completion date of the project. Any warranty beyond the first two years is an agreement between the owner and the contractor and falls outside the performance bond obligation.

2. Warranty Period: Five (5) years from date of Substantial Completion.

1.10 ROOF SYSTEM DESCRIPTION

A. Hybrid Modified Roofing System on Metal Deck.

1. Fastened insulation, Fastened insulation, asphalt, cover board, asphalt, base sheet, asphalt, ply sheet, asphalt, ply sheet, asphalt, SBS Modified Cap Sheet.
2. Fastened insulation, Fastened insulation, asphalt, cover board, asphalt, base sheet, asphalt, ply sheet, asphalt, ply sheet, cold-applied adhesive, SBS Modified Cap Sheet.

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:

1. Modified Bituminous Membrane Roofing System Manufacturer’s:

a. Firestone Building Products Company.
b. CertainTeed Corporation.
c. GAF Materials Corporation.
d. Johns Manville International, Inc.
e. Performance Roofing Systems, Inc.
f. TAMKO Roofing Products, Inc.
g. Tremco, Inc.
h. Or an Approved Substitution.

B. Substitutions: Any proposed substitution to the list of Manufacturer's above must be approved a minimum of 10 days in advance of the bid date by submitting the "SUBSTITUTION REQUEST" form enclosed with the bidding documents.

1. No substitutions will be accepted for roof systems after the bid date.

2.2 MODIFIED ASPHALT CAP-SHEET

A. SBS Roofing Membrane Cap Sheet (Hot Applied): ASTM D 6164, Grade G, Type II, non-woven polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:

1. Granule Color: White.
2. Thickness 160 mils minimum
3. Fire Resistant Sheet
4. Acceptable Manufacturer's Products

a. Firestone: SBS Premium FR Type II
b. Certainteed: Flintlastic FR-P
c. GAF: Ruberoid Mop FR
d. Johns Manville: Dynalastic 250 FR
e. Performance Roofing: NA
f. TAMKO: Awaplan Premium ER
g. Tremco: POWERply HE FR

2.3 BASE-SHEET MATERIALS

A. SBS Modified Base Sheet: ASTM D 6163, Type II, Grade S, SBS modified Bitumen, glass-fiber reinforced base sheet as a base layer in a modified Bitumen roof assembly.

1. To be adhered between the coverboard and Type IV plies in a mopping of hot asphalt.
2. Acceptable Manufacturer's Products

a. Firestone: SBS BASE
b. Certainteed: Flexiglas FR Basesheet
c. GAF: Ruberoid Modified Base Sheet
d. Johns Manville: Dyna Base
e. Performance Roofing: NA
f. TAMKO: Versa-Base
g. TREMCO: POWERply HT Base

2.4 PLY SHEET MATERIALS

A. Glass-Fiber Ply Sheet: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.

1. Type IV interplies to be adhered in hot asphalt between the base sheet and cap sheet.
2. Acceptable Manufacturer's Products

a. Firestone: PLY IV (4) M
b. Certainteed: Flintglas Type IV Plysheet
c. GAF: GAFGLAS PLY 4
d. Johns Manville: Glas Ply IV
e. Performance Roofing: PRS Glass Ply IV
f. TAMKO: TAM PLY IV
g. TREMCO: Thermglass Type IV

2.5 BASE FLASHING SHEET MATERIALS

A. SBS Flashing Sheet (Hot Asphalt Application): ASTM D 6164, Grade G, Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:

1. Thickness: 160 mil
2. Granule Color: White.
3. Fire Resistant Sheet
4. Acceptable Manufacturer's Products

a. Firestone: SBS PREM FR
b. Certainteed: Flintlastic FR-P
c. GAF: Ruberoid Mop FR
d. Johns Manville: Dynalastic 180 S
e. Performance Roofing: NA
f. TAMKO: Awaplan Premium
g. TREMCO: POWERply HE FR

2.6 AUXILIARY ROOFING MEMBRANE MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

B. Asphalt Primer: ASTM D 41.

C. Roofing Asphalt: ASTM D 312, Type III or IV as recommended by roofing system manufacturer for application.

D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application. To be used only if approved for application by the manufacturer under the project parameters.

E. Mastic Sealant: Polyisobutylene, plain or modified Bitumen, non-hardening, non-migrating, non-skinning, and nondrying.

F. Mechanical Fasteners (Metal Deck): Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roofing membrane components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

G. Metal Flashing Sheet: Metal flashing sheet is specified in Division 7 Section "Sheet Metal Flashing and Trim."

H. Roofing Granules: To match the factory applied granules on the cap sheet installed.

I. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

2.7 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, glass-fiber mat facer on both major surfaces.

1. Preformed units to fit applications indicated, selected from the manufacturer's standard thicknesses, widths, and lengths.
2. Manufacturers:

a. Atlas Roofing Corporation.

b. Firestone Building Products Company.
c. GAF Materials Corporation.
d. Johns Manville International, Inc.
e. Certainteed Corp.
f. Approved Equal and acceptable to Roof System Manufacturer.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches, unless otherwise indicated, by the same manufacturer of the Polyisocyanurate board insulation.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.8 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Asphalt Primer (Masonry Application): ASTM D 41.

C. Mechanical Fasteners (Metal Deck Only): Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roofing membrane and insulation components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

D. Cold Fluid-Applied Low-Rise Foam Adhesive: Manufacturer's standard cold fluid-applied low-rise foam adhesive formulated to adhere roof insulation to substrate.

E. Insulation Cant Strips: ASTM C 728, perlite insulation board.

1. Approved for use in a Class A roof system.
2. Approved for use in the roof assembly by the roof system manufacturer.

F. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

1. Approved for use in a Class A roof system.
2. Approved for use in the roof assembly by the roof system manufacturer.

G. Wood Cant Strip: Comply with the requirement in Division 6, Section “Rough Carpentry”.

H. Tapered Edge Strips: ASTM C 728, perlite insulation board.

1. Approved for use in a Class A roof system.
2. Approved for use in the roof assembly by the roof system manufacturer.

I. Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

1. Approved for use in a Class A roof system.
2. Approved for use in the roof assembly by the roof system manufacturer.

J. Cover Board: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board, ½-inch thick.

1. Approved for use in a Class A roof system.
2. Approved for use in the roof assembly by the roof system manufacturer.

K. Cover Board: ASTM C 728, perlite insulation board, 3/4-inch thick, with top surface seal-coated.

1. Approved for use in a Class A roof system.

2. Approved for use in the roof assembly by the roof system manufacturer.

2.9 WALKWAYS

A. SBS Walkway Cap Sheet Strips (Hot Applied Application): ASTM D 6164, Grade G, Type I or II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:

1. Granule Color: Contrasting color to the granules on the cap sheet installed.
2. Acceptable Manufacturer's Products

a. Firestone: SBS CAP
b. Certainteed: Flintlastic GMS
c. GAF: Ruberoid Mop
d. Johns Manville: Dynalastic 250 FR
e. Performance Roofing: NA
f. TAMKO: Awaplan Premium ER
g. TREMCO: POWERply Standard

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and set and braced.
2. Verify that wood cants, 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 the roof system manufacturer's requirements

4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
5. 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 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 GENERAL INSTALLATION REQUIREMENTS

A. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

1. Install roofing system per the approved Spec plate and narrative that was submitted by the contractor and approved by the designer per this specification section under require submittals.

B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel when required by the manufacturer or when requested by the designer or owner's representative.

C. Cooperate with the construction administrator and allow for inspection of the roof system as it is being installed.

D. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

E. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.

F. Absolutely No Torching of the membrane, flashing plies or any other components will be allowed.

1. Do not use a torch to dry any substrate unless pre-approved and as directed by the owner's representative with approval from the designer.

G. Coordinate installing roof accessories, blocking, and nailers that are integral with the roof system.

1. Temporarily flash until permanent flashing or similar measures can be put in place to prevent water from entering the roof system or building below.

H. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.4 SLIP SHEET INSTALLATION

A. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches and 6 inches, respectively. Minimally tack to deck to hold in place.

3.5 HEAVY WEIGHT BASE SHEET INSTALLATION

A. Install one lapped coated heavy-weight base sheet course on top of the slip sheet and mechanically fasten to substrate according to roofing system manufacturer's written instructions and in accordance with the FMG requirements for this project.

3.6 INSULATION INSTALLATION

A. Comply with roofing system manufacturer's written instructions for installing roof insulation.

B. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

C. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

D. Install tapered insulation on roof to conform to slopes indicated or as indicated on approved shop drawings.

E. Mechanically Fastened Insulation (Metal Decks): Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

F. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Stagger joints from joints in insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and secure to roof deck.

1. Install in a mopping of hot roofing asphalt and immediately bond to previous layer of insulation.

G. Preformed Saddles and Crickets: Install and secure preformed saddles and crickets where indicated and secure as follows:

1. Install in a mopping of hot roofing asphalt and immediately bond to substrate
2. Install in a cold fluid-applied low-rise foam adhesive as recommended by the roof system manufacturer.

H. Insulation Cant Strips: Install and secure, 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes greater than 45 degrees.

1. Install in a mopping of hot roofing asphalt and immediately bond to substrate
2. Install in a cold fluid-applied low-rise foam adhesive as recommended by the roof system manufacturer.

I. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

1. Install in a mopping of hot roofing asphalt and immediately bond to substrate
2. Install in a cold fluid-applied low-rise foam adhesive as recommended by the roof system manufacturer.

3.7 SBS BASE-SHEET INSTALLATION

A. Install lapped SBS base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Adhere to substrate in a solid mopping of hot roofing asphalt.

3.8 TYPE IV PLY SHEET INSTALLATION

A. Install two (2) glass-fiber TYPE IV ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Shingle side laps of glass-fiber base-ply sheets uniformly to ensure required number of glass-fiber base-ply sheets covers substrate at any point. Shingle in direction to shed water. Extend glass-fiber base-ply sheets over and terminate beyond cants.

1. Embed each glass-fiber ply sheet in a continuous mopping of hot roofing asphalt, to form a uniform membrane without glass-fiber ply sheets touching.

3.9 SBS-MODIFIED BITUMENOUS MEMBRANE CAP SHEET INSTALLATION (HOT ASPHALT)

A. Install SBS modified Bituminous roofing cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing cap sheet over and terminate beyond cants, installing as follows:

1. Unroll roofing cap sheets and allow them to relax for time period required by manufacturer.
2. Adhere to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F.
3. Adhere to preceding plies in cold-applied adhesive.
4. Prepare and seal seams per the manufacturer’s written instructions.

B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

1. Repair tears and voids in laps and lapped seams not completely sealed.
2. Apply roofing granules to cover bleed-out at laps while material is hot.

C. Install roofing membrane sheets so side and end laps shed water.

3.10 FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F. Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.
3. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer and heat weld all seams.

B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing or extend up, and over parapet and fasten to the outside of the parapet.

D. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.

3.11 WALKWAY INSTALLATION

A. Walkway Cap Sheet Strips: Install roofing membrane walkway cap sheet strips over roofing membrane in hot roofing asphalt applied at not less than 425 deg F.

3.12 FIELD QUALITY CONTROL

A. A Punch walk-thru by the Designer and Construction Administrator is required at the time of substantial completion.

1. Notify the Construction Administrator and Designer at least 5 days prior to the date and time of the inspection
2. A punch list will be issued by the designer indicating any deficiencies noted in the installation and damages caused by the contractor.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.

1. Notify Architect or Owner 48 hours in advance of date and time of inspection.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

D. Repair or replace items damaged caused by the contractor or subcontractors.

E. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements when necessary.

3.13 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Protect other roof areas adjacent to the work from damage due to construction operations.

D. Do not store materials on or traffic roofs that are not part of the scope of work without approval.

E. Clean overspray and spillage from adjacent construction using cleaning agents and procedures that will not damage or discolor the materials being cleaned.

3.14 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work on the following project:

1. Owner: State of Missouri
2. Address: P.O. Box 809, 301 West High Street, Jefferson City, Missouri 65102
3. Building Name/Type: Fulton Reception and Diagnostic Correctional Center
4. Address: 1391 Route O, Fulton, MO 65251
5. Area of Work: Housing units D, E, F, G, K, L and M
6. Acceptance Date: _____
7. Warranty Period: Five (5) Years from the date of substantial completion.
8. Expiration Date: _____

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. Lightning,
    b. Peak gust wind speed exceeding 72 mph,
    c. Fire,
    d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition,

e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work,
f. Vapor condensation on bottom of roofing; and
g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.

3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.

4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. The liability of the Surety Company under the installer warranty provisions of this contract is limited to correcting defective workmanship and materials for a period of two years from the substantial completion date of the project. Any warranty beyond the first two years is an agreement between the owner and the contractor and falls outside the performance bond obligation.

8. 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 _____, 20_____.

1. Authorized Signature: _____
2. Name: _____
3. Title: _____

END OF SECTION 075216

SECTION 075423 – THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

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. Adhered thermoplastic polyolefin (TPO) roofing system.

B. Related Sections:
   1. Section 061000 “Rough Carpentry” Wood Nailers associated with roofing and roof insulation.
   2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter flashings.
   3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   1. Fire/Windstorm Classification: Class 1A-90.
   2. Hail Resistance: SH-Severe Hail.

D. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

E. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

1.5 ACTION SUBMITTALS

A. Product Data and Informational Submittals: For each type of product indicated.
   1. Field membrane (fleece back).
   2. Flashing membrane (bare back).
   3. Membrane and flashing adhesive.
   4. Sample warranty.
   5. Manufacturer certificate stating roofing installer is a certified applicator.
   6. Safety data sheet for each product data submitted.
   7. Cover page for submittal package.
   8. Scope of work summary page for submittal package.
   9. Submittals shall be reviewed and accepted by roofing membrane manufacturer.
   10. If not by technical staff of manufacturer, submittals shall be reviewed and accepted by third party agency.
   11. Manufacturer certificate stating additional warranty services will be conducted by a technical representative.
   12. If not by technical staff of manufacturer, manufacturer certificate stating additional warranty services will be conducted by third party services.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Base flashings and membrane terminations.
   2. Strip in flashings.
   3. Shop drawings shall be reviewed and accepted by roofing membrane manufacturer.
   4. If not by technical staff of manufacturer, shop drawings shall be reviewed and accepted by third party agency.
   5. Cover page for shop drawing package.

C. Samples for Verification: For the following products:
   1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
   2. Walkway pads or rolls.

D. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed and FM approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. The installer must use company employees; contract labor is not acceptable. Full time supervision is required.

C. Exterior Fire-Test Exposure: ASTM E 108, Class A for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

D. Pre-installation Roofing Conference: Conduct conference at project site.
   1. Meet with Owner, Engineer, Architect, Owner's insurer if applicable, roofing Installer, roofing system manufacturer's technical representative, third party representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, shop drawings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect 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.

1.7 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.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Entire installation of roofing system and flashing work shall be of quality required for acceptance by membrane manufacturer in order to obtain a Full Systems No Dollar Limit material and workmanship warranty. Services may be provided by either the roofing membrane manufacturer’s technical representative or by third party services. Provide guaranty from date of substantial completion of project.
1. Includes membrane sheets, base flashings, roofing accessories, and other components of roofing system.
2. Final inspection by membrane manufacturer’s technical representative.
3. Two-year follow-up audit by roofing membrane manufacturer’s technical representative.
4. Project start up site visit, typically first or second day of construction by membrane manufacturer’s technical representative or third-party services.
5. Interim site visit for every two weeks of construction by membrane manufacturer’s technical representative or third-party services.
6. Roofing Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TPO MEMBRANE ROOFING

A. TPO Sheet: ASTM D 6878, fabric reinforced (polyester) and fleece backed.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carlisle SynTec Incorporated.
      b. Firestone Building Products Company.
      c. Johns Manville.
      d. GAF
      e. Mule-Hide Products
      f. Versico Versifleece
   2. Thickness: 60 mils nominal.
   3. Exposed Face Color: White.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Plastic Foam Adhesives: 50 g/L.
      b. Multipurpose Construction Adhesives: 70 g/L.
      c. Fiberglass Adhesives: 80 g/L.
      d. Single-Ply Roof Membrane Adhesives: 250 g/L.
      e. Other Adhesives: 250 g/L.
      f. Welding Compounds: 510 g/L.
      g. Single-Ply Roof Membrane Sealants: 450 g/L.
      h. Non-Membrane Roof Sealants: 300 g/L.
      i. Sealant Primers for Nonporous Substrates: 250 g/L.
      j. 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 sheet membrane, less the fleece back.

C. Bonding Adhesive: Manufacturer's standard solvent based.

D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

E. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

H. Provide tapered polyisocyanurate edge strips (at drain locations).
   1. Dual component polyurethane adhesive used to attach tapered edge strip.

2.3 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces.
   1. Thickness of Insulation: Install insulation in a thickness to achieve a minimum R-30, unless noted otherwise.
   2. Insulation shall be provided by the roofing manufacturer.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), unless noted otherwise.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.4 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.

D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch (16 mm) thick.

2.5 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer. Locations include working side of units and beneath wall ladders.
   1. Size: Approximately 36 by 60 inches.

2.6 OTHER MATERIALS

A. All other materials not specifically described but required for a complete and proper installation of the work in this Section shall be as selected by the Contractor, approved by the manufacturer, and subject to approval by the Owner.

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 blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

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 installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
   1. Install sheet according to ASTM D 5036.

B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing. Fully adhere. Ribbon pattern of adhesive is unacceptable.

E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.

F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

3.4 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.5 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.6 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane 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.

3.7 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: State of Missouri
   2. Address: P.O. Box 809, 301 West High Street, Jefferson City, MO 65102.
   3. Building Name/Type: Fulton Reception and Diagnostic Correctional Center
   4. Address: 1391 Route O, Fulton, MO 65251
   5. Area of Work: _____
   6. Acceptance Date: _____
   7. Warranty Period: _____
   8. Expiration Date: _____

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:
   1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
      a. Lightning
      b. Peak gust wind speed exceeding 115 mph
      c. Fire
      d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition.
      e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
      f. Vapor condensation on bottom of roofing; and
      g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
   2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
   3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
   4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
   5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
   6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
   7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, 20_____.
   1. Authorized Signature: _____
   2. Name: _____
   3. Title: _____

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

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. Manufactured through-wall flashing with counterflashing.
   2. Manufactured reglets with counterflashing.
   3. Formed equipment support flashing.

B. Related Requirements:
   1. Section 06 1000 "Rough Carpentry" for wood nailers, curbs, and blocking.

1.3 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.

1.4 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.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.

3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of roof-penetration flashing.
8. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
9. Include details of special conditions.
10. Include details of connections to adjoining work.
11. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employ 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.

1.9 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. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

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.

1.10 WARRANTY

A. 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 according to ASTM D 2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with 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 tested according to SPRI ES-1 and capable of resisting the following design pressure:
1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
1. As-Milled Finish: Mill.
2. Exposed Coil-Coated Finish:
a. Two-Coat Fluoropolymer: AAMA 620. 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.
3. Color: As selected by Architect from manufacturer's full range, includes “premium” or “metallic”.
4. 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.

C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
1. Finish: 2D (dull, cold rolled).

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
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. Atlas Roofing Corporation; Summit.

b. Engineered Coated Products; Nova-Seal II.
c. Kirsch Building Products, LLC; Sharkskin Ultra.
d. SDP Advanced Polymer Products Inc; Palisade.

C. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.4 MISCELLANEOUS MATERIALS

A. General: 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 or manufactured item 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 or manufactured item.
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.
b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
2. Fasteners for Copper-Clad Stainless-Steel Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
5. Fasteners for Zinc-Tin Alloy-Coated Stainless-Steel Sheet: Series 300 stainless steel.
6. Fasteners for Zinc-Coated (Galvanized) Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
7. Fasteners for Zinc Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Solder:
1. For Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.

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 wide and 1/8 inch thick.

E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane 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 C 1311, 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 according to ASTM D 1187.

I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Through-Wall, Ribbed, Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry, with ribs at 3-inch intervals along length of flashing to provide integral mortar bond. Manufacture through-wall flashing with interlocking counterflashing on exterior face, of same metal as flashing.
   1. Stainless Steel: 0.016 inch thick.
      a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Cheney Flashing Company; Cheney Flashing Dovetail.
         2) Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
         3) Keystone Flashing Company, Inc.; Keystone Three-Way Interlocking Thruwall Flashing.
         4) Sandell Manufacturing; Pre-Formed Metal Flashing.

B. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cheney Flashing Company.
      b. Fry Reglet Corporation.
      c. Heckmann Building Products, Inc.
      d. Hickman, W. P. Company.
      e. Hohmann & Barnard, Inc.
      f. Keystone Flashing Company, Inc.
      g. National Sheet Metal Systems, Inc.
      h. Sandell Manufacturing.
   2. Material: Stainless steel, 0.019 inch thick.
   3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
   5. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
   6. Accessories:
      a. 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 Drawings show reglet without metal counterflashing.
      b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
   7. Finish: With manufacturer's standard color coating.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   1. 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.
   2. Obtain field measurements for accurate fit before shop fabrication.
   3. 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.
   4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

G. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

H. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

I. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

J. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

K. Do not use graphite pencils to mark metal surfaces.

2.7 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.016 inch thick.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
   1. Aluminum: 0.032 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, 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 sheathing or backing substrate to prevent air infiltration or water penetration.

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

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

3.3 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.
6. Do not use graphite pencils to mark metal surfaces.

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 or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
2. 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. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Section 07 9200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
   1. Do not solder metallic-coated steel and aluminum sheet.
   2. Do not pre-tin zinc-tin alloy-coated stainless steel and zinc-tin alloy-coated copper.
   3. Do not use torches for soldering.
   4. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
   5. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
   6. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
   7. Copper-Clad Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.

H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.

C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of through-wall flashing is specified in Section 04 2000 "Unit Masonry."

C. Reglets: Installation of reglets is specified in Section 04 2000 "Unit Masonry."

D. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.6 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

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.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. Extent of each form and type of joint sealer is indicated on drawings and by provisions of this section.

B. The applications for joint sealers as work of this section include the following:

1. Concrete construction joints.
2. Wall joints (exterior).
3. Flashing joints.
4. Interior wall/ceiling joints.
5. Joints at doors, window frames and other materials.
6. Joints between dissimilar materials.

1.3 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, handling/installation/curing instructions, and performance tested data sheets for each elastomeric product required.

B. Samples: Submit 2, 12" long samples of each color required (except black) for each of sealant and caulking compound exposed to view. Install sample between 2 strips of material similar to or representative of typical surfaces where compound will be used, held apart to represent typical joint widths.

1.4 JOB CONDITIONS

A. Weather Conditions: Do not proceed with installation of liquid sealants under unfavorable weather conditions. Install elastomeric sealants when temperature is in lower third of temperature range recommended by manufacturer for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Sealer Performance Requirements: Provide colors indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated.

B. Elastomeric Sealants: For exterior use.

1. Two-Component Polyurethane Sealant: Polyurethane-based 2-part elastomeric sealant, complying with FS TT-S-00227, Class A, Type 1 (self-leveling) unless Type 2 recommended by manufacturer for application shown.
2. Products offered by manufacturers to comply with requirements include the following:

a. Type 1 - THC-900; Tremco Inc.
b. Type 2 - Dymeric; Tremco Inc.
c. Sikaflex-2c SL

3. Color: In general, the following colors shall be used:

a. Adjacent to Aluminum or Metal: Match color of metal.
b. Adjacent to other exterior wall material (both sides): Match color of wall material.

C. Nonsag Urethane Sealants – Multi-component:

1. Products offered by manufacturers to comply with requirements include the following:

a. Mameco International; Vulkem 227
b. Pecora; Dynatrol II.
c. Sika; Sikaflex 2C
d. Sonneborn; Sonolastic NPII
e. Tremco; DyMeric 240

D. Latex Joint Sealants: For interior use.

1. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.
2. Products offered by manufacturers to comply with requirements include the following:

a. Tremflex 834; Tremco Inc.
b. Pecora AC-20

E. Paintable Silicone Sealant: Where indicated provide an all-purpose paintable silicone that combines the benefits of a silicone sealant with the paintability of a latex caulk. Sealant shall be an interior/exterior sealant used to seal cracks or joints in or between wood, glass, fiberglass, metal, trim, ducts, pipes and foundations. Characteristics shall be:

1. Lifetime guarantee
2. Interior/Exterior use
3. Seals out moisture, air, dust, dirt, insects & noise
4. Paintable watertight seal
5. Permanent flexible
6. Specially formulated to resist discoloration due to mildew & rust
7. Provide the following or an approved equal:

a. Silicone 1 All Purpose Silicone Caulk as manufactured by GE.

F. Miscellaneous Materials:

1. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.
2. Sealant Backer Rod: Compressible rod stock of polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended by sealant manufacturer for compatibility with sealant.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

3.2 JOINT PREPARATION

A. Clean out joints immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which could interfere with bond or sealant or caulking compound. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer. Roughen vitreous and glazed joint surfaces as recommended by sealant manufacturer.

B. Prime or seal joint surfaces where indicated, and where recommended by sealant manufacturer. Do not allow primer/sealer to spill or migration onto adjoining surfaces.

3.3 INSTALLATION

A. Set joint filler units as depth or position in joint to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.

B. Install sealant backer rod for liquid-applied sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.

C. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

D. Install sealant to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of bead.

1. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.
2. For joint sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth of 50% of joint width.

E. Spillage: Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

F. Recess exposed edges of gaskets and exposed joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.

3.4 CURE AND PROTECTION

A. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealers during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of substantial completion.

END OF SECTION 079200

SECTION 079216 – PICK-PROOF JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pick-proof joint sealants for the following applications, including those specified by reference to this Section:
   1. All moving and non-moving joints in all areas exposed to inmates and where shown on the drawings.
   2. Use epoxy sealant at required joints and intersections of fixtures and systems in Housing Units and other areas as noted.
   3. All pick-proof joint sealants within inmate areas shall be provided and installed by the Contractor/ Subcontractor.

B. Related Sections include the following:
   1. Division 07 Section "Joint Sealants" for sealing joints within the building other than in security areas or applications.

1.2 PERFORMANCE REQUIREMENTS

A. Provide pick-proof joint sealants that provide "pick-proof" properties in high security areas and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.3 ACTION SUBMITTALS

A. Product Data: For each pick-proof joint sealant product indicated.

B. Samples: For each type and color of joint sealant required, provide 2 Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Product certificates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following products or an approved equal.

B. Manufacturers: Subject to compliance with requirements, the product that may be incorporated into the Work shall be the following – no substitutions:

   1. Dyna-Poxy EP-1200; by Pecora Corporation. (in all cells – sleeping and holding, dayrooms)
   2. Dyna-Flex SC, by Pecora Corporation. (Exercise yards, inmate corridors, sallyports – man and vehicle, at dissimilar materials and control joints)

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by 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 PICK-PROOF JOINT SEALANTS

A. Two-Part Epoxy Pick-Proof Sealant: Comply with ASTM C 881, Type I, rigid, two-part, high-solids, high-modulus epoxy resin compound, especially designed for security applications.

B. Hardness: Pick-proof sealant to have a Shore D hardness of 85.

1. Epoxy pick-proof sealants should not be used in active joints or in areas where it may come into contact with food. It should not be subjected to harsh chemicals such as acids or solvents and should not be applied in concrete joints less than 30-days old.

C. One-part, Non-sag, tamper resistant elastomeric STPU joint sealant.

D. Hardness: Tamper resistant joint sealant to have a Shore D hardness of 50.

E. Joint Design: The width or depth of the joint should not be less than 1/4" (6 mm). In joints up to 3/8" (9 mm) wide but not exceeding 1-1/4" (31 mm), the depth should be maintained at 3/8" (9 mm). For joints wider than 1-1/4" (31 mm), consult the manufacturer.

2.4 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

1. For the firmer support recommended for pick-proof sealing, use the closed-cell polyethylene rod that will compress 25% when inserted into the joint. In joints too shallow for backer rod, use a polyethylene bond-breaker tape to prevent three-sided adhesion.

C. Bond-Breaker Tape: Polyethylene tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: If recommended by the manufacturer, material recommended for adhesion of sealant to joint substrates indicated.

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 PREPARATION

A. Surface Preparation: Surfaces must be clean, sound and free of surface water. Remove laitance, curing compounds, coatings, oil, grease, rust, waxes and other bond-inhibiting substances.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer. 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 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.

3.2 MIXING AND APPLICATION

A. Mix sealant as instructed by the manufacturer in the exact ratios recommended and thoroughly mix to obtain optimum performance. Mix with a variable speed drill with mixing paddles. Apply sealant to joints using standard caulking equipment.

B. Seal all joints with pick-proof joint sealant in all areas exposed to inmates, all cracks in and around the windows, doors, frames, light fixtures, detention equipment, plumbing fixtures, etc. that are larger than the thickness of a credit card, and that can be used to conceal contraband, razor blades, knife blades, etc.

C. Tooling: Tool at once after application to ensure full adhesion. Tooling without a slicking agent is preferred but if conditions require one, mineral spirits is recommended.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

D. Cleaning: Immediately remove all excess sealant and smears adjacent to joints with mineral spirits. Also use mineral spirits for removing uncured sealant from equipment. Remove cured sealant by scraping, sandpapering, etc.

E. Precautions: Installer shall strictly follow the manufacturer's precautions concerning protective clothing, ventilation, contact with the material and breathing of the fumes.

END OF SECTION 079216

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. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For dimpled steel studs and runners and firestop tracks, from ICC-ES.

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 E 119 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for the conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
   2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
   1. Steel Studs and Runners:
      a. Minimum Base-Metal Thickness: As indicated on Drawings or 20 gage minimum. Engineered equivalent to minimum thickness not acceptable.
      b. Depth: As indicated on Drawings.
   2. Dimpled Steel Studs and Runners:
      a. Minimum Base-Metal Thickness: As indicated on Drawings or 20 gage minimum. Engineered equivalent to minimum thickness not acceptable.

b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
2) MBA Building Supplies; Slotted Deflecto Track.
3) Steel Network Inc. (The); VertiClip SLD VertiTrack VTD Series.
4) Superior Metal Trim; Superior Flex Track System (SFT).
5) Telling Industries; Vertical Slip Track Vertical Slip Track II.

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 0.033 inch.

F. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: As indicated on Drawings 0.033 inch.
2. Depth: 7/8 inch.
3. Configuration: hat shaped.

H. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:
   1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch-wide flanges.
   1. Depth: 2-1/2 inches.

F. Furring Channels (Furring Members):
   1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
   2. Steel Studs and Runners: ASTM C 645.
      a. Minimum Base-Metal Thickness: 20 gage. Engineered equivalent to minimum thickness not acceptable.
      b. Depth: As indicated on Drawings.
   3. Dimpled Steel Studs and Runners: ASTM C 645.
      a. Minimum Base-Metal Thickness: 20 gage minimum. Engineered equivalent to minimum thickness not acceptable.
      b. Depth: As indicated on Drawings.
   4. Hat-Shaped, Rigid Furring Channels ASTM C 645, 7/8 inch deep.
      a. Minimum Base-Metal Thickness: 20 gage minimum. Engineered equivalent to minimum thickness not acceptable.
   5. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
      a. Configuration: Asymmetrical.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, 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.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, , or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 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 o.c. unless otherwise indicated.
   2. Multilayer Application: 16 inches 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 (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
   1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
   2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
      a. Install two studs at each jamb unless otherwise indicated.
      b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
      c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
      d. Install runner tracks on each side of double jamb studs and fasten the entire system with screws.
   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.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING 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 o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches 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. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 2216

SECTION 092900 - GYPSUM BOARD

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. Interior gypsum board.

B. Related Requirements:
   1. Section 09 2216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

1.5 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.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 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 E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. American Gypsum.
   2. CertainTeed Corp.
   3. Georgia-Pacific Gypsum LLC.
   4. Lafarge North America Inc.
   5. National Gypsum Company.
   6. PABCO Gypsum.
   7. Temple-Inland.
   8. USG Corporation.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch (15.9 mm).
   2. Long Edges: Tapered.

C. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 3. Basis of Design shall be Dens Armor Plus Impact
   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Long Edges: Tapered.
   3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
   2. Shapes:
      a. Cornerbead.
      b. Bullnose bead.
      c. LC-Bead: J-shaped; exposed long flange receives joint compound.
      d. L-Bead: L-shaped; exposed long flange receives joint compound.
      e. U-Bead: J-shaped; exposed short flange does not receive joint compound.

f. Expansion (control) joint.
g. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fry Reglet Corp.
b. Gordon, Inc.
c. Pittcon Industries.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
3. Finish: Class II anodic finishes.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
1. Interior Gypsum Board: Paper.
2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.

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 setting-type taping compound.
a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping 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.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (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, except floors. 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.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type X: Vertical surfaces unless otherwise indicated.
   2. Abuse-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-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. 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.

D. Control Joints: Install control joints at locations indicated on Drawings, do not exceed 30'-0" and install at each side of door heads.

E. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners unless otherwise indicated.
2. Bullnose Bead: Use where indicated.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use at exposed panel edges.
6. F-Mold: Use where indicated.

3.4 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, 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 C 840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
a. Primer and its application to surfaces are specified in Section 09 9123 "Interior Painting."

3.5 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 the 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 099123 - PAINTING

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 surface preparation and field painting of exposed exterior and interior items and surfaces.
   1.
   2. Work of this Section includes surface preparation, priming, and finish coats specified in this Section. Surfaces which have shop priming and surface treatment specified in other Sections that is in satisfactory condition, need only the required surface preparation (cleaning) and two finish coats, unless specifically noted otherwise.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
   1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment which have been factory primed but do not have a factory-applied final finish.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Architectural woodwork and casework.
      b. Finished mechanical and electrical equipment.
      c. Light fixtures.
      d. Distribution cabinets.
   2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
      a. Furred areas.
      b. Ceiling plenums.
      c. Pipe spaces.
      d. Duct shafts.
   3. Finished metal surfaces include the following:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Copper and copper alloys.
      e. Bronze and brass.
   4. Operating parts include moving parts of operating equipment and the following:
      a. Valve and damper operators.
      b. Linkages.
      c. Sensing devices.
      d. Motor and fan shafts.
   5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for shop priming ferrous metal.
   2. Division 9 Section "Gypsum Board Assemblies" for surface preparation of gypsum board.
   3. Division 9 Section "Interior Epoxy Coatings" for special coatings.
   4. Division 23: Painting of mechanical work is specified in Division 23.

1.3 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.
   1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
   2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
   1. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.
   1. Architect will select one room or surface to represent surfaces and conditions for application of each type of coating and substrate.
      a. Wall Surfaces: Provide samples on at least 100 sq. ft. (9 sq. m).
   2. Apply benchmark samples, according to requirements for the completed Work. Provide required sheen, color, and texture on each surface.
      a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
   3. Final approval of colors will be from benchmark samples.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.

7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain storage containers in a clean condition, free of foreign materials and residue.
1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.6 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F (10 and 32 deg C).

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F (7 and 35 deg C).

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.7 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and, in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
1. Quantity: Furnish Owner with an additional 5 percent, but not less than 1 gal. (3.8 L) or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in the Finish Schedule on the Drawings.

B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1.
2. Iowa Paint Manufacturing Co. Inc. (IPM)
3. Benjamin Moore & Co. (Moore).
4. ICI Dulux/ Devoe Coatings (ICI).
5. PPG Industries, Inc. (Pittsburgh).
6. Pratt & Lambert, Inc. (P & L)
7. Sherwin-Williams Co. (S-W).
8. Kwal Paint (Kwal)
9.

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying the manufacturer's product identification will not be acceptable.

C. Colors: Match colors selected by the Architect and indicated by reference to manufacturer's color designations. If required, provide custom colors to match Architect's samples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
   1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

A. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime.
   2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
      a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.

3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view, smooth and dust off.
   a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand and smooth when dried.
   b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.
   c. If transparent finish is required, backprime with spar varnish.
   d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on back side.
   e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
4. Ferrous Metals: Clean un-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
   a. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 10/NACE No. 2.
   b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
   c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
5. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

A. Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors on tops, bottom, and side edges the same as exterior faces.
9. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:
1. Uninsulated metal piping.
2. Uninsulated plastic piping.
3. Pipe hangers and supports.
4. Tanks that do not have factory-applied final finishes.
5. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
6. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
7. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

G. Electrical items to be painted include, but are not limited to, the following:
1. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
1. Provide satin finish for final coats.

L. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 EXTERIOR PAINT SCHEDULE

A. CSM - Exterior Concrete and Concrete Masonry Units (CMU)
1. CSM - LLAC - Exterior Low-Luster Acrylic Paint: Provide 2 finish coats of low-sheen (eggshell) acrylic-latex paint over a primer (a block filler at CMU).
a. PCSM - Exterior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex primer for exterior application.
1) ICI; 2000-1200 Dulux Professional Exterior 100 Percent Acrylic Latex Primer: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).
2) IPM;Sterling Acrylic Exterior Primer #3545; Applied at a dry film thickness of not less than 2 mils.
3) Kwal:5860 100% Acrylic Primer Undercoat: Applied at a dry film thickness of not less than 1.8 mils.

4) Moore; Moore's Acrylic Masonry Sealer No. 066: Applied at a dry film thickness of not less than 0.7 mils (0.018 mm).
5) Pittsburgh; 6-603 SpeedHide Interior/Exterior Acrylic Latex Alkali Resistant Primer: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
6) P & L;Weather Flex - Cement & Stucco Primer - 380-5545: Applied at a dry film thickness of not less than 1.5 - 2 mils.
7) S-W; Loxon Exterior Masonry Acrylic Primer A24W300: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. CMUBF - Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.
1) ICI Paint; Bloxfil 4000-1000 Interior/Exterior Heavy Duty Acrylic Block Filler: Applied at a dry film thickness of not less than 7.0 to 14.5 mils (0.178 to 0.368 mm).
2) IPMPrime Line Acrylic Block Filler #3008; Applied at a dry film thickness of not less than 8.0 mils.
3) Kwal:5890 Accu-Pro Latex Block Filler: Applied at a dry film thickness of not less than 8 to 12 mils.
4) Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils (0.206 mm).
5) Pittsburgh; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils (0.152 to 0.318 mm).
6) P & L;Z-8465 - Pro-Hide Silver Heavy Duty Block Filler. Applied at a dry film thickness of not less than 8 mils.
7) S-W; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils (0.203 mm).

c. First and Second Coats:
1) ICI; 2402-XXXX Dulux Professional Exterior 100 Percent Acrylic Satin Finish: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
2) IPM;Pro House Acrylic Satin #4600: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:7100 Liquid Vinyl 100% Acrylic Satin: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Low Lustre Latex House Paint No. 185: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
5) Pittsburgh; 6-2000 Series SpeedHide Exterior House & Trim Satin-Acrylic Latex: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
6) P & L;Z-1900 - Vapex Flat House Paint: Applied at a dry film thickness of not less than 1.1 mils
7) S-W; A-100 Exterior Latex Satin House & Trim Paint A82 Series: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).

2. CSM - SGAC - Exterior Semigloss Acrylic Enamel: Provide 2 finish coats of semigloss waterborne acrylic-latex enamel over a primer (a block filler at CMU).
a. PCSM - Exterior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex primer for exterior application.
1) ICI; 2000-1200 Dulux Professional Exterior 100 Percent Acrylic Latex Primer: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).
2) IPM;Sterling Acrylic Primer #3545: Applied at a dry film thickness of not less than 2 mils.
3) Kwal:5860 100% Acrylic Primer Undercoat: Applied at a dry film thickness of not less than 1.8 mils.
4) Moore; Moore's Acrylic Masonry Sealer No. 066: Applied at a dry film thickness of not less than 0.7 mils (0.018 mm).
5) Pittsburgh; 6-603 SpeedHide Interior/Exterior Acrylic Latex Alkali Resistant Primer: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).

6) P & L;Weather Flex - Cement & Stucco Primer - 380-5545: Applied at a dry film thickness of not less than 1.5 - 2 mils.
7) S-W; Loxon Exterior Masonry Acrylic Primer A24W300: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. CMUBF - Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.
1) ICI Paint; Bloxfil 4000-1000 Interior/Exterior Heavy Duty Acrylic Block Filler: Applied at a dry film thickness of not less than 7.0 to 14.5 mils (0.178 to 0.368 mm).
2) IPMPrime Line Acrylic block Filler #3008: Applied at a dry film thickness of not less than 8 mils.
3) Kwal:5890 Accu-Pro Latex Block Filler: Applied at a dry film thickness of not less than 8 to 12 mils.
4) Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils (0.206 mm).
5) Pittsburgh; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils (0.152 to 0.318 mm).
6) P & L;Z-8465 - Pro-Hide Silver Heavy Duty Block Filler. Applied at a dry film thickness of not less than 8 mils.
7) S-W; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils (0.203 mm).

c. First and Second Coats:
1) ICI; 2406-XXXX Dulux Professional Exterior 100 Percent Acrylic Semi-Gloss Finish applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
2) IPM;Sterling Acrylic Gloss House Paint #3800: Applied at a dry film thickness of not less than 1.4 mils.
3) Kwal:3200 Ambassador 100% Acrylic S/G Block Resistant Enamel: Applied at a dry film thickness of not less than 1.6 mils.
4) Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils (0.028 mm).
5) Pittsburgh; 6-900 Series SpeedHide Exterior House & Trim Semi-Gloss Acrylic Latex Paint: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
6) P & L;Z-3100 - Aqua Royal Latex House & Trim. Applied at a dry film thickness of not less than 1.3 mils.
7) S-W; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

B. FM - Exterior Ferrous Metal
1. FM - SGAC - Exterior Semigloss Acrylic Enamel: Provide 2 finish coats of semigloss waterborne acrylic-latex enamel over a primer.
a. PFM - Exterior Ferrous-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.
1) ICI; 4160-XXXX Devguard Multi-Purpose Tank & Structural Primer. Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
2) IPM;Meta-Kote Rust Inhibitive Metal Primer #1064: Applied at a dry film thickness of less than 2 mils.
3) Kwal:9210 Accu-Pro Rust Inhibiting Primer. Applied at a dry film thickness of not less than 2.0 mils.
4) Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
5) Pittsburgh; 90-712 Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
6) P & L;S3206/S3207 SteelTec Universal Primer: Applied at a dry film thickness of not less than 2 - 2.5 mils.

7) S-W; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. First and Second Coats:

1) ICI; 2406-XXXX Dulux Professional Exterior 100 Percent Acrylic Semi-Gloss Finish applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

2) IPM;Sterling Acrylic Gloss House Paint #3800: Applied at a dry film thickness of not less than 1.4 mils.

3) Kwal:3200 Ambassador 100% Acrylic S/G Block Resistant Enamel: Applied at a dry film thickness of not less than 1.6 mils.

4) Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils (0.028 mm).

5) Pittsburgh; 6-900 Series SpeedHide Exterior House & Trim Semi-Gloss Acrylic Latex Paint: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).

6) P & L;Z-3100 Aqua Royal Latex House & Trim: Applied at a dry film thickness of not less than 1.3 mils.

7) S-W; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

2. FM - FGAC - Exterior Full-Gloss Acrylic Enamel Paint System: Provide 2 finish coats of full-gloss waterborne acrylic-latex enamel over a primer.

a. PFM - Exterior Ferrous-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.

1) ICI; 4160-XXXX Devguard Multi-Purpose Tank & Structural Primer. Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

2) IPM;Meta-Kote Rust Inhibitive Metal Primer #1064: Applied at a dry film thickness of not less than 2 mils.

3) Kwal:9210 Accu-Pro Rust Inhibiting Primer. Applied at a dry film thickness of not less than 2.0 mils.

4) Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

5) Pittsburgh; 90-712 Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

6) P & L;S3206/S3207 SteelTec Universal Primer: Applied at a dry film thickness of not less than 2 - 2.5 mils.

7) S-W; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. First and Second Coats:

1) ICI; 3028-XXXX Dulux Interior/Exterior Acrylic Gloss Finish: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

2) IPM;Meta Cryl DTM #19207: Applied at a dry film thickness of not less than 2 mils.

3) Kwal:8400 Ambassador 100% Acrylic Gloss Block Resistant Enamel: Applied at a dry film thickness of not less than 1.5 mils.

4) Moore; Moore's IMC Acrylic Gloss Enamel M28: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

5) Pittsburgh; 90-300 Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

6) P & L;Z-2900 Enducryl DTM Gloss Acrylic Maintenance Enamel: Applied at a dry film thickness of not less than 2 mils.

7) S-W; DTM Acrylic Coating Gloss (Waterborne) B66W100 Series: Applied at a dry film thickness of not less than 2.4 mils (0.061 mm).

C. ZM - Exterior Zinc-Coated Metal

1. ZM - LLAC - Exterior Low-Luster Acrylic Paint: Provide 2 finish coats of low-sheen (eggshell) acrylic-latex paint over a primer.

a. PZM - Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.
   1) ICI; 4020-XXXX Devflex DTM Flat Interior/Exterior Waterborne Primer & Finish: Applied at a dry film thickness of not less than 2.2 mils (0.056 mm).
   2) IPM;Meta-Cryl Pure Acrylic Galvanized Primer #1069: Applied at a dry film thickness of not less than .5 mils and not more than 1. mil.
   3) Kwal:5810 Ambassador G-Prime Acrylic Metal Primer.
   4) Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
   5) Pittsburgh; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
   6) P & L;Primer not required on new galvanized metal. Apply 2 finish coats.
   7) S-W; primer not required over this substrate.

b. First and Second Coats:
   1) ICI; 2402-XXXX Dulux Professional Exterior 100 Percent Acrylic Satin Finish: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
   2) IPM;Pro House Acrylic Satin #4600: Applied at a dry film thickness of not less than 1.5 mils.
   3) Kwal:7100 Liquid Vinyl 100% Acrylic Satin: Applied at a dry film thickness of not less than 1.5 mils.
   4) Moore; Moorcraft Super Spec Low Lustre Latex House Paint No. 185: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
   5) Pittsburgh; 90-400 Series Pitt-Tech One Pack High Performance Waterborne Satin DTM Industrial Enamels: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
   6) P & L;Z-1800 Aqua Shell Latex House & Trim: Applied at a dry film thickness of not less than 1.4 mils.
   7) S-W; A-100 Exterior Latex Satin House & Trim Paint A82 Series: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).

2. ZM - SGAC - Exterior Semigloss Acrylic Enamel: Provide 2 finish coats of semigloss waterborne acrylic-latex enamel over a primer.
   a. PZM - Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.
      1) ICI; 4020-XXXX Devflex DTM Flat Interior/Exterior Waterborne Primer & Finish: Applied at a dry film thickness of not less than 2.2 mils (0.056 mm).
      2) IPM;Meta-Cryl Pure Acrylic Galvanized Primer #1069: Applied at a dry film thickness of not less than .5 mils and not more than 1. mil.
      3) Kwal:5810 Ambassador G-Prime Acrylic Metal Primer.
      4) Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
      5) Pittsburgh; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
      6) P & L;Primer not required on new galvanized metal. Apply 2 finish coats.
      7) S-W; primer not required over this substrate.
   b. First and Second Coats:
      1) ICI; 2406-XXXX Dulux Professional Exterior 100 Percent Acrylic Semi-Gloss Finish applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
      2) IPM;Sterling Acrylic Gloss House Paint #3800: Applied at a dry film thickness of not less than 1.4 mils.
      3) Kwal:3200 Ambassador 100% Acrylic S/G Block Resistant Enamel: Applied at a dry film thickness of not less than 1.6 mils.
      4) Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils (0.028 mm).
      5) Pittsburgh; 6-900 Series SpeedHide Exterior House & Trim Semi-Gloss Acrylic Latex Paint: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).

6) P & L;Z-3100 Aqua Royal Latex House & Trim: Applied at a dry film thickness of not less than 1.3 mils
7) S-W; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

D. AM - Exterior Aluminum
1. AM - SGAC - Exterior Semigloss Acrylic Enamel: Provide 2 finish coats of semigloss waterborne acrylic-latex enamel over a primer.
a. PAMAC - Exterior Aluminum Primer under Acrylic Finishes: Factory-formulated acrylic-based metal primer for exterior application.
1) ICI; 4020-XXXX Devflex DTM Flat Interior/Exterior Waterborne Primer & Finish: Applied at a dry film thickness of not less than 2.2 mils (0.056 mm).
2) IPMMeta-Cryl Pure Acrylic Galvanized Primer #1069: Applied at a dry film thickness of not less than .5 mils and not more than 1 mil.
3) Kwal:5820 W.B. Industrial DTM Primer. Applied at a dry film thickness of not less than 1.8 mils.
4) Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
5) Pittsburgh; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
6) P & L: Primer not required. Apply 2 finish coats.
7) S-W; primer not required over this substrate.
b. First and Second Coats:
1) ICI; 2406-XXXX Dulux Professional Exterior 100 Percent Acrylic Semi-Gloss Finish applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
2) IPM;Sterling Acrylic Gloss House Paint #3800: Applied at a dry film thickness of not less than 1.4 mils.
3) Kwal:3200 Ambassador 100% Acrylic S/G Block Resistant Enamel: Applied at a dry film thickness of not less than 1.6 mils.
4) Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils (0.028 mm).
5) Pittsburgh; 6-900 Series SpeedHide Exterior House & Trim Semi-Gloss Acrylic Latex Paint: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
6) P & L;Z-3100 Aqua Royal Latex House & Trim: Applied at a dry film thickness of not less than 1.3 mils
7) S-W; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

3.7 INTERIOR PAINT SHEDULE

A. CSM - Interior Concrete and Concrete Masonry Units (CMU)
1. CSM - LLAC - Interior Low-Luster Acrylic Paint System: Provide 2 finish coats of eggshell acrylic-latex paint over a primer (a block filler at CMU).
a. PCSMAC - Interior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.
1) ICI; 1030-1200 Ultra-Hide PVA Interior Primer-Sealer General Purpose Wall Primer: Applied at a dry film thickness of not less than 1.9 mils (0.048 mm).
2) IPM;All Purpose Acrylic Undercoat #3301: Applied at a dry film thickness of not less than 2 mils.
3) Kwal:0800 Accu-Tone Hi-Hide PDQ Sealer: Applied at a dry film thickness of not less than 1.4 mils.
4) Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils (0.030 mm).

5) Pittsburgh; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
6) P & L;Z-1001 Suprime "1" 100% Acrylic Multi-Purpose Primer; Applied at a dry film thickness of not less than 1.5 mils.
7) S-W; PrepRite Masonry Primer B28W300: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. CSM - LLAC Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.
1) ICI; 1402-XXXX Dulux Professional Acrylic Eggshell Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
2) IPMMaster Series Eggshell Enamel #2300: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:2100 Accu-Pro PC Latex Eggshell: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
5) Pittsburgh; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils (0.032 mm).
6) P & L;Z-8200 Pro-Hide Gold Interior Latex Eggshell: Applied at a dry film thickness of not less than 1.5 - 2.5 mils.
7) S-W; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

2. CSM - SGAC - Interior Semigloss Acrylic Paint System: Provide 2 finish coats of Semigloss acrylic-latex enamel over a primer.
a. PCSMAC - Interior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.
1) ICI; 1030-1200 Ultra-Hide PVA Interior Primer-Sealer General Purpose Wall Primer: Applied at a dry film thickness of not less than 1.9 mils (0.048 mm).
2) IPM;All Purpose Acrylic Enamel Undercoat #3301: Applied at a dry film thickness of not less than 2 mils.
3) Kwal:0800 Accu-Tone Hi-Hide PDQ Sealer: Applied at a dry film thickness of not less than 1.4 mils.
4) Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils (0.030 mm).
5) Pittsburgh; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm)
6) P & L;Z-1001 Suprime "1" 100% Acrylic Multi-Purpose Primer; Applied at a dry film thickness of not less than 1.5 mils.
7) S-W; PrepRite Masonry Primer B28W300: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. CSM - SGAC Interior Semigloss Acrylic Enamel: Factory-formulated semigloss acrylic-latex enamel for interior application.
1) ICI 1406-XXXX Dulux Professional Acrylic Semi-Gloss Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
2) IPM;Master Series Semi-Gloss Enamel #3200: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:3000 Accu-Pro Latex Semi Gloss: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Latex Semi-Gloss Enamel No. 276: Applied at a dry film thickness of not less than 1.2 mils (0.031 mm).
5) Pittsburgh; 6-500 Series SpeedHide Interior Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
6) P & L;Z-8300 Pro-Hide Gold Interior Latex Semi-Gloss: Applied at a dry film thickness of not less than 2 mils.

7) S-W; ProMar 200 Interior Latex Semi-Gloss Enamel B31W200 Series: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

B. GB - Interior Gypsum Board
1. GB - LLAC - Interior Low-Luster Acrylic Paint System: Provide 2 finish coats of eggshell acrylic-latex enamel over a primer.
a. PGB - Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.
1) ICI; 1000-1200 Dulux Ultra Basecoat Interior Latex Wall Primer: Applied at a dry film thickness of not less than 1.2 mils (0.031 mm).
2) IPM;Prime Line Hi Hiding PVA Primer #514: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:0890 Accu-Pro Sandable Primer: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils (0.030 mm).
5) Pittsburgh; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).
6) P & L.Z-1004 Suprime "4" Interior Latex Wallprimer: Applied at a dry film thickness of not less than 1.2 mils.
7) S-W; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).
b. GB - LLAC Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.
1) ICI; 1402-XXXX Dulux Professional Acrylic Eggshell Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
2) IPM;Master Series Eggshell Enamel #2300: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:2100 Accu-Pro PC Latex Eggshell: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
5) Pittsburgh; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils (0.032 mm).
6) P & L;Z-8200 Pro-Hide Gold Interior Latex Eggshell: Applied at a dry film thickness of not less than 1.5 - 2.5 mils.
7) S-W; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

C. WH - Interior Wood and Hardboard
1. WH - LLAC - Interior Low-Luster Acrylic Paint System: Provide 2 finish coats of eggshell acrylic-latex enamel over a primer.
a. PWAC - Interior Wood Primer for Acrylic-Enamel and Semigloss Alkyd-Enamel Finishes: Factory-formulated alkyd- or acrylic-latex-based interior wood primer.
1) ICI; 3210-1200 Ultra-Hide Aquacrylic GRIPPER Stain Killer Primer Sealer: Applied at a dry film thickness of not less than 1.8 mils (0.046 mm).
2) IPM;Prime Line Latex Fast Dry Wood Undercoat #517: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:0890 Accu-Pro Sandable Primer: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Alkyd Enamel Underbody and Primer Sealer No. 245: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
5) Pittsburgh6-855 SpeedHide Latex Enamel Undercoater: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).

6) P & L;S-1011 Suprime "11" Interior Alkyd Wood Primer: Applied at a dry film thickness of not less than 1.4 mils.
7) S-W; PrepRite Wall and Wood Primer B49W200 Series: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

b. WH - LLAC Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.
1) ICI; 1402-XXXX Dulux Professional Acrylic Eggshell Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
2) IPM;Master Series Eggshell Enamel #2300: Applied at a dry film thickness of not less than 1.5 mils.
3) Kwal:2100 Accu-Pro PC Latex Eggshell: Applied at a dry film thickness of not less than 1.5 mils.
4) Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
5) Pittsburgh; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils (0.032 mm).
6) P & L;Z-8200 Pro-Hide Gold Interior Latex Eggshell: Applied at a dry film thickness of not less than 1.5 - 2.5 mils.
7) S-W; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils (0.041 mm).

D. FM - Interior Ferrous Metal
1. FM - SGALK - Interior Semigloss Alkyd Paint System: Provide 2 finish coats of Semigloss alkyd enamel over a primer.
a. PFM - Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.
1) ICI; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
2) IPM;Meta-Kote Rust Inhibitive Metal Primer #1064: Applied at a dry film thickness of not less than 2 mils.
3) Kwal:9210 Accu-Pro Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils.
4) Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
5) Pittsburgh; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/ Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
6) P & L:S3206/S3207 SteelTech Universal Primer: Applied at a dry film thickness of not less than 2 - 2.5 mils.
7) S-W; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).

b. FM - SGALK Interior Semigloss Alkyd Enamel: Factory-formulated semigloss alkyd enamel for interior application.
1) ICI; 1516-XXXX Ultra-Hide Alkyd Semi-Gloss Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.7 mils (0.043 mm).
2) IPM;Synex Semi Gloss Alkyd Enamel #302: Applied at a dry film thickness of not less than 2 mils.
3) Kwal:4600 Accu-Pro Alkyd Semi Gloss: Applied at a dry film thickness of not less than 1.7 mils.
4) Moore; Moorcraft Super Spec Alkyd Semi-Gloss Enamel No. 271: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
5) Pittsburgh; 6-1110 Series SpeedHide Interior Enamel Wall & Trim Semi-Gloss Oil: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
6) P & L;S-8800 Pro-Hide Gold Alkyd Semi-Gloss: Applied at a dry film thickness of not less than 1.5 mils.

7) S-W; ProMar 200 Interior Alkyd Semi-Gloss Enamel B34W200 Series: Applied at a dry film thickness of not less than 1.7 mils (0.043 mm).

E. ZM - Interior Zinc-Coated Metal
1. ZM - SGALK - Interior Semigloss Alkyd Paint System: Provide 2 finish coats of Semigloss alkyd enamel over a primer.
a. PZM - Interior Zinc-Coated Metal Primer: Factory-formulated galvanized metal primer.
1) ICI; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
2) IPM;Meta-Cryl Pure Acrylic Galvanized Primer #1069: Applied at a dry film thickness of not less than .5 mils and not more than 1 mil.
3) Kwal:5810 Ambassador G-Prime Acrylic Metal Primer: Applied at a dry film thickness of not less than 1.6 mils.
4) Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
5) Pittsburgh; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
6) P & L;Z-190 Enducryl DTM Primer Finish: Applied at a dry film thickness of not less than 2 - 3 mils
7) S-W; Galvite HS B50WZ30: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
b. ZM - SGALK Interior Semigloss Alkyd Enamel: Factory-formulated semigloss alkyd enamel for interior application.
1) ICI; 1516-XXXX Ultra-Hide Alkyd Semi-Gloss Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.7 mils (0.043 mm).
2) IPMSynex Semi Gloss Alkyd Enamel #302: Applied at a dry film thickness of not less than 2 mils.
3) Kwal:4600 Accu-Pro Alkyd Semi Gloss: Applied at a dry film thickness of not less than 1.7 mils.
4) Moore; Moorcraft Super Spec Alkyd Semi-Gloss Enamel No. 271: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
5) Pittsburgh; 6-1110 Series SpeedHide Interior Enamel Wall & Trim Semi-Gloss Oil: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
6) P & L;S-8800 Pro-Hide Gold Alkyd Semi-Gloss Enamel: Applied at a dry film thickness of not less than 1.5 mils
7) S-W; ProMar 200 Interior Alkyd Semi-Gloss Enamel B34W200 Series: Applied at a dry film thickness of not less than 1.7 mils (0.043 mm).

F. SIZE - Interior Insulation Covering
1. SIZE - FAC - Interior Flat Latex-based Paint System: Provide 2 finish coats of flat latex -based paint over an all-service jacket insulation covering. If plastic jackets are used as covering over insulation, consult manufacturers to determine that product listed is suitable.
a. SIZE - Interior Flat Latex-Emulsion Size: Factory-formulated flat latex-based interior paint.
1) ICI; 1200-XXXX Dulux Professional Velvet Matte Interior Flat Latex Wall & Trim Finish: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).
2) IPM;Master Series Latex Flat Enamel #1900: Applied at a dry film thickness of not less than 1.4 mils.
3) Kwal:0910 Accu-Pro Velva Sheen Interior Flat: Applied at a dry film thickness of not less than 1.6 mils.
4) Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils (0.031 mm).
5) Pittsburgh; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm).

6) P & L;Z-8100 Pro-Hide Gold Interior Latex Flat: Applied at a dry film thickness of not less than 2 mils

7) S-W; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils (0.036 mm).

G. Concrete Floors:

1. Sealed Concrete Light Duty – Pedestrian Traffic: All exposed concrete floors scheduled to be "sealed concrete" shall receive Hillyard Concrete Primer, followed by Hillard MT Concrete Seal – clear. Depending on the condition of concrete surface, prepare and apply MT Concrete Seal in the number of coats as recommended by the manufacturer.

H. Striping Paint for Interior Concrete Floors

a.

2. Concrete Floor Marking Paint: Alkyd-resin type; ready mixed; complying with FS TT-P-115, Type I, or AASHTO M 248, Type N. Color as selected by Architect from manufacturer's standard colors.

END OF SECTION 099123

SECTION 099656 - INTERIOR EPOXY COATINGS

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 surface preparation and field application of interior epoxy coating systems to items and surfaces scheduled. Type of epoxy systems required is as follows:

1. Two-component, epoxy emulsion.

B. Related Sections include the following:

1. Division 09 Section "Painting" for general field painting.

1.3 DEFINITIONS

A. Standard coating terms defined in ASTM D 16 apply to this Section.

B. Gloss ranges used in this Section include the following:

1. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
2. High gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each coating system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.

B. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

C. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. List of material and application for each coat of each sample. Label each sample for location and application.

3. Submit samples on the following substrates for Architect's review of color and texture:
    a. Concrete Masonry: Provide two 8-inch- (200-mm-) square samples of masonry, with mortar joint in the center, for each finish and color.
    b. Gypsum Drywall: Provide two 8-inch- (200-mm-) long samples of each color and material on drywall.

D. Qualification Data: For 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 specified information.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Mockups: Provide a full-coat mockup finish sample of each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.

1. Architect will select one room, area, or surface to represent surfaces and conditions for application of each type of coating and substrate.

    a. Wall Surfaces: Provide samples on at least 100 sq. ft. (9 sq. m) of wall surface.
    b. Small Areas and Items: Architect will designate items or areas required.

2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface as specified. Provide the required sheen, color, and texture of each surface.

    a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from mockup samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.7 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 45 and 95 deg F (7 and 35 deg C).

1.8 EXTRA MATERIALS

A. Furnish extra high-performance coating materials from the same production run as materials applied and in quantities described below. Package coating materials in unopened, factory-sealed containers for storage and identify with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.785 L) or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer/ Products: Subject to compliance with requirements, provide one of the selected products below:

B. Manufacturers' Names: The following manufacturers are referred to in the coating system descriptions by shortened versions of their names shown in parenthesis:

1. ICI Dulux Paints; Devoe Coatings (ICI Devoe).
2. Moore: Benjamin Moore & Co. (Moore).
3. Pittsburgh Paint; PPG Industries, Inc. (PPG).
4. Sherwin Williams; Industrial and Marine Coatings (S-W).
5. Kwal (Kwal).
6. Tnemec Company, Inc. (Tnemec).

2.2 COATINGS MATERIALS, GENERAL

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials 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.

B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying the manufacturer’s product identification are not acceptable.
1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.

2.3 INTERIOR EPOXY COATING SYSTEMS

A. Provide the following coating systems for substrates indicated:

1. Where undercoats or other conditions show through final coat, apply additional coats until the cured film is of uniform coating finish, color, and appearance.

B. Concrete Masonry Units:

1. Two-Component, Epoxy Emulsion Coating: Provide two finish coats of semigloss, epoxy emulsion over concrete masonry block filler.

a. Filler Coat: Concrete masonry block filler.

1) ICI Devoe: Bloxfil 4000 Int/Ext Heavy Duty Acrylic Block Filler.
2) Kwal: 5890 Acrylic Block Filler
3) Moore: M-88 Latex Block Filler.
4) PPG: 16-90 High Performance Acrylic Block Filler.
5) S-W: Heavy Duty Block Filler B42W46.
6) Tnemec: 130-6602 Envirofill.

b. First and Second Finish Coats: Semigloss, epoxy emulsion.

1) ICI Devoe: Tru-Glaze-WB 4406 Waterborne Epoxy Semi-Gloss Coating
2) Kwal: 3190 Semi-Gloss W/B Catalyzed Epoxy
3) Moore: M43/M44-86 Series Semi-Gloss Acrylic Epoxy.
4) PPG: 16-551 Series Pitt-Glaze Low Odor High Solids Acrylic Epoxy.
5) S-W: Water Based Catalyzed Epoxy, B70 Series B60V25.
6) Tnemec: Series 113 H.B. Tneme-Tufcoat.

C. Drywall:

1. Two-Component, Epoxy Emulsion Coating: Provide two finish coats of factory-formulated, semigloss, epoxy emulsion over base coat.

a. Prime Coat: Manufacturer's recommended latex primer which is compatible with the specified finish system.

1) Kwal: 0890 Sandable Drywall Primer
2) Moore: 253 Latex Drywall Primer.

b. Finish Coats: b, epoxy emulsion.

1) ICI Devoe: Tru-Glaze-WB 4406 Waterborne Epoxy Semi-Gloss Coating.
2) Kwal: 3190 Semi-Gloss W/B Catalyzed Epoxy
3) Moore: Poly-amide Water-based Epoxy, M43/M44, Semi-Gloss.
4) PPG: 16-551 Series Pitt-Glaze Low Odor High Solids Acrylic Epoxy.
5) S-W: Water Based Catalyzed Epoxy, B70 Series B60V25.
6) Tnemec: Series 113 H.B. Tneme-Tufcoat.

2.4 INTERIOR EPOXY COATING COLOR SCHEDULE

A. EP-#: Color: Match colors indicated in the Materials Legend on the Drawings (P-1, P-2, etc.) that reference the general paint color designations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.
2. Start of application is construed as Applicator's acceptance of surfaces within that particular area.

B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

a. Confirmation of primer's suitability for expected service conditions.
b. Confirmation of primer's ability to be top coated with specified materials.

2. Notify Architect about anticipated problems before using the coatings specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

B. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

C. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove primers and reprime substrate.
2. Cementitious Substrates: Prepare concrete, brick, concrete masonry block, and cement plaster surfaces to be coated. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods to prepare surfaces.

a. Use abrasive blast-cleaning methods if recommended by coating manufacturer.
b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not coat surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

D. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

3.3 APPLICATION

A. General: Apply epoxy coatings according to manufacturer's written instructions.

1. Use applicators and techniques best suited for the material being applied.
2. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
3. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
4. Provide finish coats compatible with primers used.
5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, grilles, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

    a. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
    b. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required is the same regardless of application method.

    a. Omit primer on metal surfaces that have been shop primed and touchup painted.
    b. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
    c. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.
    d. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.

2. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

C. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
b. Brush out and work brush coats into surfaces in an even film.
c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.

a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
b. Apply each coat to provide the equivalent hiding of brush-applied coats.
c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

D. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

G. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 CLEANING

A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
2. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

END OF SECTION 09965

SECTION 200548 - SEISMIC CONTROLS FOR MEPFT SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. This section includes requirements for seismic controls to be installed for project, the design for which is a delegated design responsibility.

1.2 DEFINITIONS

A. Section Title: Seismic Controls for Mechanical, Electrical, Plumbing, Fire Protection, and Technology (MEPFT).

B. ASCE: American Society of Civil Engineers.

C. Component Importance Factor: As defined in ASCE 7-latest edition, Chapter 13.

D. IBC: International Building Code.

E. ICC-ES: ICC-Evaluation Service.

F. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 ADMINISTRATIVE REQUIREMENTS

A. The contractor shall be responsible for determining the requirements for seismic control measures to be applied to HVAC piping and equipment, electrical conduit and raceways, electrical switchgear and plumbing systems specified herein. Seismic protection criteria used to determine seismic control requirements of all mechanical, electrical and plumbing systems shall be determined by the applicable code adopted in the project jurisdiction. Where not already determined within the contract documents, the contractor shall be responsible for contracting a licensed professional engineer to establish building site class, seismic use group, occupancy category, seismic design category, seismic zone or any other criteria necessary to determine the requirements for seismic control measures for mechanical, electrical and/or plumbing systems.

B. Where required, the Contractor shall be responsible for determining the type and location of seismic supports required for the HVAC piping and equipment, electrical conduit and raceways and plumbing elements shown on the contract drawings based on the seismic criteria, the size and weight of the supported element and the distance from structure that the element will be installed. The Contractor shall submit shop drawings as defined in Paragraph “Submittals” showing the types and locations of required seismic supports.

C. The requirements for seismic control measures to be applied to HVAC piping and equipment, electrical conduit and raceways, electrical switchgear and plumbing systems specified herein are in addition to any other items called for in other sections of these specifications. All anchor connections to structure for support of mechanical/electrical equipment, regardless of the need for seismic restraints, shall be shown on shop drawings and submitted for review by the Engineer of Record.

D. At the Contractor’s option, use pre-engineered seismic restraints produced by the manufacturers specified in part 2.1 of this section. Spacing of seismic restraints may be

modified in these pre-engineered systems to meet seismic design parameters when properly engineered and documented.

E. All seismic restraints, isolators, and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

F. Seismic protection systems shall be installed in strict accordance with all applicable local, state, and/or federal codes. Installation shall also be in strict accordance with component manufacturer's requirements and standards and with industry construction standards. Whenever conflicts occur between codes or standards, the most stringent shall apply.

G. Seismic protection of fire protection piping systems shall be installed in strict accordance with the provisions of NFPA 13 (2010 or later edition).

1.4 SUBMITTALS

A. Seismic Control Measure Analysis: The contractor shall provide an analysis determining the requirement or exemption for seismic control measures for mechanical, electrical and plumbing equipment. The analysis shall be signed and sealed by a licensed professional structural engineer.

1. The analysis shall at a minimum include the following:

a. For projects permitted under Uniform Building Code

1) UBC Seismic Zone

2) Seismic Zone Factor

3) Occupancy Category

b. For projects permitted under International Building Code

1) Seismic Use Group or Building Category.

2) Seismic Design Category

3) Site Class

4) Design Spectral Response Acceleration Values

c. For projects with equipment mounted outdoors and subject to wind restraint requirements:

1) Basic Wind Speed.

2) Building Classification Category

3) Minimum 10lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Where seismic control measure analysis determines seismic controls are not required:

1. Submit report that summarizes the analysis for review and approval.

2. Disregard the remaining portions of this submittal section

C. Where seismic control measure analysis determines seismic controls are required:

1. Submit report that summarizes the analysis for review and approval

2. Provide submittals for seismic bracing as required in the remaining portions of this submittal section.

D. Product Data: The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

E. Delegated-Design Submittal: Submit seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Design of seismic restraint components shall meet the requirements of ASCE 7.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators and seismic restraints.

a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.

3. Seismic and Wind Restraint Details:

a. Design Analysis: Submit report that supports selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.

c. Preapproval and Evaluation Documentation: Where required provide preapproval documentation from an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

F. Shop Drawings: The following items shall be signed and sealed by a registered professional engineer:

1. Shop drawings along with catalog cuts, templates, erection, and installation details, as appropriate, for the items listed below shall be submitted for approval. Submittals shall be complete in detail; shall indicate thickness, type, grade, class

of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to other building systems and construction.

a. Sway Braces

b. Flexible Couplings or Joints

c. Resilient Type Vibration Devices

d. Equipment Anchor Connections

e. Fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

f. Details of suspension and support for ceiling hung equipment.

g. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

h. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

2. Layout drawings showing locations and types of seismic restraints for all equipment, ductwork, piping and conduit shall be submitted. Locations for seismic restraints shall be coordinated with the structure and with other mechanical and electrical components. Coordinate types of restraints with the submitted schedule

3. Indicate components exempt from seismic due to exceptions for component importance factor, component response modification factor, component amplification factor, seismic design category, etc.

G. Seismic Certification and Analysis:

1. Seismic restraint calculations shall be provided for all connections of equipment to the structure. Calculations shall be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the project location.

2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Testing and calculations shall include shear and tensile loads as well as one test or analysis at 45° to the weakest mode.

3. Analysis shall indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the code required forces acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

4. Submit certification letter stating that the special inspector has received the factory training necessary to perform the field inspection specified in Part 3 of this specification.

H. Welding certificates.

1.5 QUALITY ASSURANCE

A. Professional Engineer Qualifications (Analysis): The professional engineer shall be licensed to practice in the jurisdiction where the project is located and shall be experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for building structural and seismic requirements.

B. Professional Engineer Qualifications (Design): The professional engineer shall be legally qualified to practice in the jurisdiction where the Project is located and shall be experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

D. Seismic Restraint Manual: A seismic restraint manual shall be prepared that contains the basis of the design for the seismic support systems, product data, shop drawings and layout drawings. A copy of the seismic restraint manual shall be kept on the jobsite for the duration of the project.

E. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

F. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

G. ASCE 7: Provide seismic restraint systems meeting the requirements of ASCE 7 - latest edition “Minimum Design Loads for Buildings and Other Structures”; Chapter 13, “Seismic Design Requirements for Nonstructural Components.”

H. Comply with NFPA 70.

1.6 SPECIAL INSPECTION

A. Requirements specified herein for special inspection of important aspects of the seismic design are in addition to other requirements specified in other sections of this specification.

1.7 HVAC EQUIPMENT

A. HVAC equipment to be protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

1. Mechanical Equipment including but not limited to:

a. Rooftop Air Handling Equipment

b. Packaged Rooftop Units

c. Control Panels

d. HVAC Ductwork Systems

1.8 ELECTRICAL EQUIPMENT

A. Electrical equipment to be protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

1. Major Electrical Distribution Equipment including but not limited to

a. Panelboards

b. Switchgear

c. Transformers

d. Freestanding Disconnect

e. Control equipment (time-clocks, contactor enclosures, etc.)

2. Electrical Conduit and Raceways

1.9 PLUMBING EQUIPMENT

A. Plumbing equipment to be protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

1. Fuel Gas piping

2. Fuel Oil Piping

1.10 RELATED WORK

A. Housekeeping Pads

1. The restraint vendor shall prepare housekeeping pad reinforcement and monolithic pad attachment to the structure details and design.

2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc., as required or specified.

1.11 ATTACHMENTS

A. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the seismic vendor's calculations.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Seismic Restraints: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equals:

1. Amber/Booth Company, Inc.
2. B-Line / Tolco.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Loos & Company, Inc.
6. Mason Industries, Inc.
7. Uni-Strut.
8. Vibro-Acoustics.

B. Flexible Couplings: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equals:

1. Barco Div.
2. Flexonics, Inc.
3. Hyspan.
4. International Seismic Application Technology (ISAT).
5. Mason Industries, Inc.
6. Resistoflex.

2.2 VIBRATION ISOLATORS

A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.

1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip pattern and steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
2. Fiberglass or cork isolator pads: molded cork or glass fiber not less than 1 inch thick and pre-compressed through 10 compression cycles at 3 times the rated load.
3. Load range: from 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.

B. 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.

C. Spring Isolators: Freestanding, laterally stable, open-spring-type isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.

3. Lateral Stiffness: More than 1.0 times the rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to a 1/4-inch thick, rubber isolator pad attached to the baseplate underside. Size baseplates to limit floor loading to the structural design criteria. Contact the Engineer if design criteria is not shown on the drawings.

6. Top Plates: Provide threaded studs for fastening and leveling equipment.

7. Finishes: Manufacturer's standard corrosive-resistant finish.

D. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.

1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled baseplate for bolting to structure and bonded to a 1/4-inch thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 0.8 times the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.

E. 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.

F. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.

1. 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.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Install elastomeric grommet at bottom connection for isolation between anchor bolt and base plate or housing.

5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

2.3 SEISMIC CONTROLS

A. Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression. Factory set for thrust.

1. 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.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

B. Manufactured Seismic Snubbers: All-directional snubbers.

1. Construction: Interlocking steel members restrained by a 3/4-inch- thick, replaceable, shock-absorbing neoprene insert. Maintain 1/8-inch clearance in all directions between rigid and resilient surfaces.

C. Fabricated Seismic Snubbers: Welded structural-steel shapes designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during a seismic event. Design to resist gravity forces identified by authorities having jurisdiction.

1. Construction: Welded steel shapes conforming to ASTM A 36.

2. Resilient Components: 3/4-inch thick, replaceable, shock-absorbing neoprene insert.

2.4 VIBRATION ISOLATION BASES

A. 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.

1. Fabricate bases to shapes required, with welded structural-steel shapes, plates, and bars conforming to ASTM A 36. Include support brackets to anchor base to isolation units. Include prelocated equipment anchor bolts and auxiliary motor slide bases or rails.

2. Design and fabricate bases to result in the lowest possible mounting height with not less than 1-inch clearance above the floor.

3. Concrete-Filled Inertia Bases: Weld reinforcing bars to the structural frame. Pour concrete into base with relocated equipment anchor bolts.

4. Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.

5. Configure inertia bases to accommodate equipment supported.

6. Pump Bases: Size to support pump and piping elbows.

7. Factory Finish: Manufacturer's standard corrosive-resistant finish.

2.5 VIBRATION ISOLATION ROOF CURBS

A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 125-mph wind impinging laterally against the side of the equipment. Design restraints to meet seismic requirements of authorities having jurisdiction.

B. Components: Upper support frame; lower support assembly; freestanding, unhoused, laterally stable steel springs; vertical and horizontal restraints.

1. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer strip for attachment of roof material and 2 inches of rigid insulation on the inside of the assembly.

2. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

3. Water Seal: Elastomeric seal conforming to UL Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counterflashed over the roof materials.

2.6 MATERIALS

A. Bolts and Nuts:

1. Squarehead bolts and heavy hexagon nuts, ANSI B18.2.1 and B18.2.2, and ASTM A307 or A 576.

2. Bolts, underground, ASTM A 325.

B. Sway Brace: Except for pipes, material shall be structural steel conforming to ASTM A 36. Steel pipes shall conform to ASTM A 501.

C. Flexible Couplings: Flexible couplings shall have same pressure ratings as adjoining pipe. Where required by these specifications, flexible couplings shall be one of the following:

1. Flexible ball joints conforming to the following requirements may be employed on aboveground piping. Joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation plus not less than 15-degree angular movement. Joints shall be certified to be suitable for the service intended by the manufacturer, based on not less than 2 years' satisfactory operation in a similar application.

2. Flexible metal hose type joints may be used for aboveground or underground piping, up to 8" pipe diameter. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

D. Resilient Vibration Isolation Devices:

1. Selection of anchor bolts for vibration isolation devices and/or snubbers to equipment base and foundations shall follow the same procedure as in paragraph "Anchor Bolts".

2. Multidirectional Seismic Snubbers: Multidirectional seismic snubbers employing elastomeric pads shall be installed on all floor or slab-mounted equipment. Snubbers shall provide 0.25 inches vertical and horizontal clearances. Vertical

forces shall be resisted by the snubber medium. Provide additional structural steel supports/frame necessary for equipment to insure proper restraint.

3. Seismically Restrained Vibration Isolators: As an option to multidirectional seismic snubbers, a unitized adjustable open spring isolator and a welded steel housing designed to resist seismic forces in all directions may be utilized. Restraint surfaces which engage under seismic motion shall be cushioned with a resilient elastomer, neoprene or equal, to protect equipment.

4. Restraints shall allow a maximum of 1/4" movement before engaging and shall not interfere in normal operation. Housing shall allow for visual inspection of the spring. The entire assembly shall have a certified minimum rating of 1g. in all directions. Submit test data from independent testing lab.

5. Isolator shall be stable spring with a minimum Ky/Ky of 1.0 and the spring shall be isolated from the housing by an internal elastomeric pad on its base for sound absorption. Spring shall have a combination leveling bolt and equipment fastening device. Nuts and bolts shall be zone-electroplated to prevent corrosion. Adjusting bolt and equipment attachment shall have a minimum rating of 1g. Bolting equipment to isolator with bolts smaller than main adjusting bolt will not be allowed.

6. Baseplate shall have adequate means for bolting to the structure. If elastomeric pad for sound absorption is on baseplate of housing, anchor bolts shall be isolated with elastomeric grommets.

2.7 CABLE RESTRAINT

A. Restraint assembly for suspended equipment, piping and ductwork consisting of galvanized steel aircraft cable attached to galvanized steel thimbles or steel assemblies with two clamping bolts. Thimbles or assemblies shall be specifically designed for cable service, shall be able to swivel to final installation angle and shall be securely fastened to the equipment or equipment base and the building structure. Cables shall be sized for the force required per code with a minimum safety factor of 2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install and anchor 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. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required by authorities having jurisdiction.

4. Fill concrete inertia bases, after installing base frame, with 3000-psig concrete, and trowel to a smooth, hard finish.

5. Install pipe connectors at connections for equipment supported on vibration isolators.

6. Install cables to prevent excessive seismic motion and so arranged that they do not engage during normal operation.

B. Sway Braces for Piping, Conduit and Ducts

1. Sway braces shall be installed on piping, conduit and HVAC ducts to preclude damage during seismic activity. Provisions of this paragraph apply to all piping within a 5-foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. No trapeze-type hanger shall be secured with less than two 1/2 inch bolts. Bracing rigidly attached to pipe flanges, or similar, shall not be used where is would interfere with thermal expansion of piping.

2. Sway Braces for Piping and Conduit:

a. Horizontal Runs: Provide transverse and longitudinal sway bracing at intervals as required for the pipe size and seismic zone.

b. Vertical Runs: Vertical runs of piping 1-1/2" or greater diameter shall be braced at not more than 10-foot vertical intervals. For piping smaller than 1-1/2" diameter, bracing shall be provided at no more than 4-foot spacing.

c. Anchor Rods, Angles, and Bars: Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in place concrete or masonry insert of clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in Table III.

d. Clamps: Clamps on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps applied over insulation vapor barrier with high-density inserts and metal protection shields under each clamp.

e. Bolts: Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2 inch diameter.

3. Sway Braces for HVAC Ducts:

a. Transverse Sway Bracing: Transverse sway bracing shall be provided at each horizontal turn of 45 degrees or more, at the end of each duct run, and otherwise at intervals as required for duct size and seismic zone. Walls which ducts penetrate may be considered transverse braces.

b. Longitudinal Sway Bracing: Longitudinal sway bracing shall be provided at intervals as required for duct size and seismic zone. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it, if the bracing is installed within 4 feet of the intersection, and it is sized for the larger duct.

C. Piping and Conduit Penetration Requirements

1. All piping from 1 to 3-1/2 inches diameter shall be installed with 1" clearance on all sides and at every floor, and masonry or concrete wall penetration. A 2" clearance is required for pipe sizes larger than 3-1/2".

2. Insulated and uninsulated pipes and conduit passing through walls and partitions (except smoke and fire walls and partitions) shall be run through not less than No. 12 gauge steel pipe sleeves finishing flush with the finished wall surfaces. Where covered pipes pass through the walls or partitions, same shall be centered in steel pipe sleeves. All sleeves or thimbles shall be independent of the pipes they enclose

and centered in sleeves to insure free movement of the pipes without injury to pipe insulation, wall or other finish. Caulk around all pipes and pipe sleeves passing through walls or ceilings with untarred jute and make airtight and soundproof.

3. Insulated and uninsulated pipes and conduit passing through fire, or fire and smoke walls and partitions shall be run through rated wall sleeve assemblies sealed with UL approved sealant in accordance with its listing, meeting the approval of the authority having jurisdiction, and as indicated on details on drawings.

4. Pipe sleeves through outside walls shall be Schedule 40 steel pipe sleeves with 1-1/2"collar welded to center of sleeve and cast in wall. Caulk between sleeves and pipes and make watertight.

5. Materials and equipment shall conform to the respective specifications and other requirements specified below:

D. Spreaders

1. Provide spreaders between racked or adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart or four times the maximum displacement due to seismic force. Spreaders to be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe and over insulation utilizing high-density inserts and pipe protection shields where vapor-barrier-type insulation is employed.

E. Flexible Couplings or Joints

1. Building Piping: Flexible couplings or joints in building piping shall be provided in the following locations on pipe risers:

   a. Within 24 inches of the top and bottom of all risers. This requirement may be deleted in risers less than 3 ft. in length, and in risers 3 to 7 ft. in length, one flexible coupling is adequate.

2. Underground Piping: All underground piping and 4-inch or larger conduit, except heat distribution system, shall have flexible couplings installed adjacent to building. Additional flexible couplings shall be provided as follows:

   a. On each side of the joints of demarcation between soils having widely differing degrees of consolidation.

   b. At all points that can be considered to act as anchors.

   c. On every branch of a tee and each side of an elbow.

F. Anchor Bolts

1. All floor or pad mounted equipment required by any Section of these specifications shall use cast-in-place or female wedge type anchor bolts. Anchor bolts must conform to ASTM A 307. Female wedge anchors shall have an evaluation report number from ICBA Evaluation Service. Anchor bolts shall have an embedded straight length equal to at least twelve times nominal diameter of the bolt. If the size and number of the anchor bolts are not shown on the drawings, then anchor bolts shall conform to the applicable codes and standards for the various equipment weights or the manufacturer's installation recommendations, whichever is the most stringent.

G. Equipment Sway Bracing

1. Provide for all items supported from overhead floor or roof structures with the following requirements:

a. Braces shall consist of angles, rods, bars, or pipes secured at both ends with not less than 1/2 inch bolts. Braces shall conform to all applicable codes and standards. Bracing shall be provided in two planes of directions, 90 degrees apart, for each item of equipment. Sufficient braces shall be provided for equipment to resist a horizontal force equal to 50 percent of the weight of equipment without exceeding safe working stress of bracing components. Details of all equipment bracing shall be submitted for approval.

b. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90 degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are included at a 45 degree angle.

H. Ceiling mounted air terminals or services installed in lay-in ceilings

1. Positively attach to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.

2. Terminals or services weighing not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service or to the structure above. These wires may be slack.

3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

I. Miscellaneous Equipment

1. The following specific items of equipment to be furnished under this contract shall be constructed and assembled so as to be capable of withstanding the horizontal equivalent static force of 0.11 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

a. Air Handling Units

b. Free Standing Electric Motors

J. Floor Mounted Equipment Support

1. Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases.

2. Snubbers: Install the required number of seismic snubbers on each spring-mounted piece of equipment. Locate snubbers as close as possible to the vibration isolators and bolt to supporting structure.

3.2 ADJUSTING AND CLEANING

A. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operations.

B. Adjust thrust restraints for a maximum of 1/4 inch of movement at start and stop.

3.3 SPECIAL INSPECTION

A. Special Inspector: Employ a factory trained representative during construction to observe the work specified and to ensure that it conforms to the Contract documents. Factory trained representative shall be a qualified person who shall demonstrate competence and specialized experience, to the satisfaction of the engineer of record, for inspection of the seismic protection of mechanical and electrical equipment.

B. Inspection Requirements: The factory trained representative shall periodically inspect the following systems to verify conformance with the contract documents and the local code:

1. Installation of piping systems intended to carry flammable, combustible or highly toxic contents and their associated mechanical units in structures assigned to Seismic Design Category C, D, E or F.

2. Installation of HVAC ductwork that will contain hazardous materials in structures assigned to Seismic Design Category C, D, E or F.

3. Installation of vibration isolation systems in structures assigned to Seismic Design Category C, D, E or F where a nominal clearance of 0.25 inches or less between the equipment support frame and restraint is required.

C. Inspection Reports: Ensure that the inspection report is furnished from the special inspector to the engineer of record. At the end of the work, ensure that a final, signed report is submitted by the special inspector, stating whether the work requiring special inspection was, to the best of the special inspector's knowledge, in conformance with the Contract documents.

D. Discrepancies: Discrepancies shall be brought to the immediate attention of the Contractor for correction, and then, if uncorrected, to the architect and engineer of record.

END OF SECTION 200548

SECTION 220010 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP, or MEP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer’s requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IPC	International Plumbing Code – 2015
IFGC	International Fuel Gas Code – 2015
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Airc Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing,

anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation

until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The Contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The Contractor shall inform the Architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The Contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.8 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. Provide welders' qualification certificates.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall

indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.
    e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in Table 5.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.

B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Insulation shall be effective.

3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.

2. Work in the existing building shall be scheduled with the Owner.

3. Certain demolition work must be performed prior to the remodeling. The Plumbing Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.

4. Plumbing Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Plumbing Contractor during this demolition shall become their property and shall be removed by the Plumbing Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Plumbing Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Plumbing Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.

6. General Contractor shall install finish material.

7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 SOIL MATERIALS

A. Provide clean sand, pea gravel or flowable fill material (per the geotechnical engineer's or structural engineer's recommendations).

B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially crushed aggregate. Corrosive fill materials shall not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and be free of debris, waste, frozen materials, vegetable and other deleterious matter.

C. Filter Fabric: Flat needle punched PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4,480 to 13,440 L/min. per sq. m) when tested according to ASTM D 4491.

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection

charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in their bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing Plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.

    a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

    b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 22.

F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.4 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.

C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

E. Erect barricades around excavations. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.

1. Do not allow water to accumulate in excavations and trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks, Basins, and Plumbing Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for Plumbing installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.

5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

N. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below:

2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support after installation and testing of piping and prior to backfilling and placement of roadway subbase. Coordinate with AHJ for colored concrete requirements.

5. Other areas, use excavated or borrowed materials.

P. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

Q. Placement and Compaction: Place subgrade backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

R. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

S. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

T. Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Use of pneumatic backhoe as compaction method is not allowed as an acceptable process for compaction of excavations or trenches.

2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.

3. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.

5. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

   a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

   c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

U. Subsidence: Where subsidence occurs at Plumbing installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

V. Additional Excavation: Where additional excavation may be required due to unsuitable bearing materials encountered, notify the architect immediately for resolution.

3.5 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

G. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.6 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.7 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, The Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 220010

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:

1. Non-shrink grout for equipment installations.
2. Sleeves for Plumbing penetrations.
3. Miscellaneous metals for support of Plumbing materials and equipment.
4. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
5. Joint sealers for sealing around Plumbing materials and equipment.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 22 Section "Basic piping Materials and Methods" for materials and methods for mechanical sleeve seals.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 22 Section “General Plumbing Requirements”.

1. Product data for the following products:
    a. Through and membrane-penetration firestopping systems.
    b. Joint sealers.
2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
    a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."
5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
    a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS AND MATERIALS

2.1 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.2 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify

the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.3 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.4 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.5 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

    a. "Dow Corning 790," Dow Corning Corp.

    b. "Silglaze II SCS 2801," General Electric Co.

    c. "Silpruf SCS 2000," General Electric Co.

    d. "864," Pecora Corp.

    e. "Rhodia 5C," Rhone-Poulenc, Inc.

    f. "Spectrem 1," Tremco, Inc.

    g. "Spectrem 2," Tremco, Inc.

    h. "Dow Corning 795," Dow Corning Corp.

    i. "Rhodia 7B," Rhone-Poulenc, Inc.

    j. "Rhodia 7S," Rhone-Poulenc, Inc.

    k. "Omniseal," Sonneborn Building Products Div.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

   a. "Dow Corning 786," Dow Corning Corp.

   b. "Sanitary 1700," General Electric Co.

   c. "898 Silicone Sanitary Sealant," Pecora Corp.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. "Chem-Calk 600," Bostik Construction Products Div.

   b. "AC-20," Pecora Corp.

   c. "Sonolac," Sonneborn Building Products Div.

   d. "Tremflex 834," Tremco, Inc.

2.6 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:

1. 3M Corp., Fire Barrier Sealant
2. Hilti
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR
5. RectorSeal
6. Specified Technologies Inc.,
7. United States Gypsum Company SHEETROCK Firecode Compound
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.2 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.3 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.4 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.5 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section “Basic Piping Materials and Methods”.

END OF SECTION 220500

SECTION 220515 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Common Work Results for Plumbing" for materials and methods for sleeve materials.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. Refer to Division 01 and Division 22 Section “General Plumbing Requirements” for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Escutcheons
2. Mechanical Sleeve Seals

C. Quality Control Submittals:

1. Submit welders' certificates specified in Quality Assurance below.

D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.4 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:
    a. AWI Manufacturing.
    b. Keeney Manufacturing Company
    c. Wal-Rich Corp.
    d. Jones Stephens Corp.
2. Mechanical Sleeve Seals:
    a. Advance Products & Systems
    b. Calpico, Inc.
    c. GPT Industries/Link Seal
    d. Metraflex Co.
    e. Proco Products, Inc.

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.

B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

E. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions:

1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.

C. Sleeves:

1. Sleeve: Refer to Division 22 Section “Common Work Results for Plumbing” for sleeve materials.

D. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.5 WALL SLEEVES

A. Steel sleeve of schedule 40 pipe meeting ASTM A53B with 2” wide metal plate meeting ASTM A36 welded all around. Hot dip galvanized inside and out.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s installation instructions.

3.2 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.3 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.

C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

I. Verify final equipment locations for roughing in.

3.4 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.5 PENETRATIONS

A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Provide escutcheons for exposed pipe penetrations of interior floors, walls, ceilings and under cabinets and millwork. Use deep pattern escutcheons where required.

C. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

D. Underground, Exterior-Wall Penetrations: Provide galvanized steel wall sleeve. Wall sleeve is not required for existing concrete walls with core drilled penetrations. Size wall sleeves to allow for 1-inch or larger, if required by the mechanical sleeve seal manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2. Verify sleeve and mechanical sleeve seal installations for damage and faulty work. Verify watertight integrity of sleeves and mechanical sleeve seals installed below grade to seal against hydrostatic water pressure. If sleeve and or sleeve seal are not watertight, provide new wall sleeve and mechanical sleeve seal.

E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

F. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

2. Provide ½" thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2" above and below the concrete slab.

G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral

wool and seal both ends with minimum of ½" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

H. Exterior Wall Penetrations: Seal annular space between sleeve and pipe, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Cover exterior sealant with grout, minimum ½" thick and paint grout to match exterior color, with color selection by the architect. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

I. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

3.6 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install components with pressure rating equal to or greater than system operating pressure.

D. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.

E. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2" and larger.

3.7 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2":

a. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.

b. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque

specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.8 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF SECTION 220515

INSPECTION REPORT FORM

Project Name:
Project No: _____ Contractor Project No. _____
General Contractor: _____
Inspection Date: _____Temperature: _____

System Inspected

Building: _____
Location/Description: _____
Service: _____

Inspection Results

Time of Inspection: _____
Approval to Insulate: Y N Approval to Cover in Wall: Y N
Approval to backfill Y N

Signatures

Witness: _____ Representing: _____
Witness: _____ Representing: _____
Witness: _____ Representing: _____

Remarks

_____
_____
_____
Contractor Supervisor's signature: _____

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Piped expansion loops

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section “Hangers and Supports for Plumbing Piping”, for pipe anchors and alignment guides.

2. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties” for shielded transition couplings.

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are nominal pipe size (NPS).

B. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

1. Product data for each type of pipe expansion joints specified. Submit expansion compensation schedule showing manufacturer's figure number, size, location, connections, material and displacement for each required expansion joint.

2. Assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components. Detail fabrication of pipe anchors, hangers, special pipe support assemblies and their attachment to the building structure. Submit calculations of pipe expansion forces at anchor points for structural engineer review.

3. Shop drawings for field-fabricated expansion loops indicating location, dimensions, pipe sizes, calculations for compression or tension required, and location. Detail fabrication of pipe anchors, hangers, special pipe support assemblies and their attachment to the building structure. Submit calculations of pipe expansion forces at anchor points for structural engineer review.

4. Maintenance data for expansion joints for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Submit American Gas Association certification for expansion joints used for natural gas distribution systems.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

B. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

C. Expansion joints shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE EXPANSION JOINTS, GENERAL

A. Pipe expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors.

B. Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

C. Fittings: Materials of construction and end fitting type shall be consistent with pipe material and equipment / pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.

1.

2.2 EXPANSION LOOPS

A. Provide pipe expansion loop constructed of main pipe material. Acceptable methods include use of elbows in a U or Z shape as defined by ASHRAE or ASME; or a detailed stress analysis may be utilized to define areas of expansion.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Provide alignment guides and anchors as specified in specification Division 22 Section “Hangers and Supports for Plumbing Piping”.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install expansion joints and expansion loops where indicated on the drawings and where required for adequate expansion of installed piping system.

C. Install expansion loops in all piping crossing building expansion joints. Expansion loops shall be sized to meet or exceed building expansion as defined in the structural documents. Expansion loops shall be capable of moving in all planes. Provide hangers and supports per manufacturer’s instructions.

D. Anchor piping to ensure proper direction of expansion and contraction

E. Align joints to avoid end loading and torsional stress.

3.2 EXPANSION COMPENSATION FOR RISERS AND TERMINALS

A. Install connection between piping mains and risers with at least 5 pipe fittings including tee in main. Install connections between piping risers and terminal units with at least 4 pipe fittings including tee in riser.

3.3 EXPANSION LOOPS

A. Fabricate expansion loops to dimensions indicated. For thermal expansion loops subject loop to cold spring tension or compression necessary to absorb 50 percent of the total compression or tension during anticipated change in temperature.

B. Expansion loop locations and dimensions shall be based on routing shown on plans. If routing is modified, coordinate locations with engineer.

C. Fabricate expansion loops to dimensions indicated on plans.

D. For thermal expansion loops, install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature. After installation remove temporary space holders as required.

E. Provide hangers and supports in accordance with Division 22 Section “Hangers and Supports for Plumbing Piping”. For expansion loops with horizontal and vertical components, support for the horizontal legs shall be designed for full weight of the pipe with maximum load variation of 25%.

F. Provide alignment guides at locations indicated on plans and as required for piping expansion. At a minimum, install alignment guides on both sides of expansion loop, spaced at twice the height of the U or Z loop (height defined as perpendicular distance of piping from primary pipe direction) or as required by the expansion joint manufacturer. Alignment shall be sufficient to allow for proper installation of expansion joints to prevent binding or torsional stress on joint.

G. Provide anchors at locations indicated on plans and as required for piping expansion. At a minimum install anchors on both sides of straight pipe length incorporating expansion loop.

H. For gravity drainage systems and vent systems, connect plain end expansion compensators to hubless cast iron with shielded transition couplings. Shielded transition couplings are specified in Division 22 Section “Sanitary Drainage and Vent Piping and Specialties”.

END OF SECTION 220516

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal-piping hangers and supports.

C. Vertical piping clamps

D. Pipe alignment guides.

E. Pipe anchors.

F. Pre-engineered roof supports

G. Anchors and fasteners.

H. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data : Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, and shields at pipe hangers for each type of insulation and hanger.

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. Manufacturer's 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.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.6 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS AND MATERIALS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.
2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
    a. Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
    b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
    c. Outdoor Locations: Galvanized steel or type 304 stainless steel.
    d. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    e. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
    f. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:
    a. Cooper B-Line.
    b. PHD Manufacturing.
    c. Thomas & Betts Corporation.
    d. Unistrut, a brand of Atkore International Inc.
    e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:
    a. Indoor Dry Locations: Galvanized steel or zinc-plated steel.
    b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
    c. Outdoor Locations: Galvanized steel or type 304 stainless steel.
    d. All nuts, brackets, and clamps shall have the same finish as the channel.
5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:
1. Material:
    a. Indoor Dry Locations: Zinc-plated steel.
    b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.
2. Threaded both ends or continuously threaded.
3. Minimum Size: Reference piping specification sections for rod thicknesses.
4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12”. Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

D. Wire Rope Pipe Hanging Systems:
1. Manufacturers:
    a. ASC Engineered Solutions.
    b. Gripple.
2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
4. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.
5. Cable Stud: Carbon steel, zinc-coated, designed for attachment to concrete inserts. Model: ASC Engineered SolutionsC120.
6. Cable Coupling: Carbon steel, zinc-coated, designed for attachment to threaded rods. Model: ASC Engineered SolutionsC130.
7. Cable Eyelet: Carbon steel, zinc-coated, designed to be directly attached to structural supports via anchors or fasteners. Model: ASC Engineered SolutionsC150.

8. Cable Toggle: Carbon steel, zinc-coated, with toggle designed for insertion into 1/2 inch hole through steel deck hat channel and provides anchor when pulled in tension. Model: ASC Engineered SolutionsC160.

9. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.

10. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.

11. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. MANUFACTURERS

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Elite Components
4. ERICO/Michigan Hanger Co./Caddy
5. Halfen-DEHA.
6. Hilti.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing.
9. Power-Strut.
10. Unistrut.

B. Single Hangers:

1. Split Ring: Carbon steel, adjustable swivel, split ring type.
2. Split Ring 2 inch and smaller: Copper alloy, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.
4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:
   a. ASC Engineered Solutions.

b. Holdrite.

c. Klo-Shure.

2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Spring Hangers:

1. Reference Section “Vibration Isolation for Plumbing Piping and Equipment” for spring isolation hangers.

F. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

G. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

2.3 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.

2. Cooper B-Line, Inc.

3. Halfen-DEHA.

4. Hilti.

5. ERICO/Michigan Hanger Co.

6. National Pipe Hanger Corporation.

7. PHD Manufacturing.

8. Power-Strut.

9. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.

2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:

a. Hydra-Zorb; Titan Riser Clamp.

b. National Pipe Hanger.

c. Pipe Hangers, Inc.

D. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.4 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.

2. Pipe Diameter 10 inches and Larger: Roller type.

3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.5 PIPE ANCHORS

A. Pre-Insulated Anchors: Galvanized steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.

B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.6 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Manufacturers:

1. Airtec.

2. ASC Engineered Solutions.

3. Cooper B-Line, Inc.

4. Elite Components.

5. ERICO/Michigan Hanger Co./Caddy.

6. Miro.

7. PHP Systems/Design.

8. PHD Manufacturing.

9. Roof Top Blox.

10. Unistrut, a brand of Atkore International Inc.

11. Zsi Foster.

B. General: Pre-engineered devices with embedded pipe support fixtures as specified.

C. Pedestals: Steel pedestals with thermoplastic or rubber base with the following dimensions:

1. Up to 12 inch strut length support: 18 inch x 18 inch.
2. Up to 16 inch strut length support: 24 inch x 18 inch.
3. Up to 24 inch strut length support: 30 inch x 18 inch.
4. Thickness: Minimum 3/16 inch thick.

D. Block Bases: Closed-cell polyethylene blocks with the following dimensions.

1. Length: Nominal 10 inch, 12 inch, 16 inch, or 24 inch
2. Width: Nominal 4 inches.

E. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

F. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

2.7 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:
    a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.

b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

E. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.

2. Channel Material: Use galvanized steel.

3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.

4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.

5. Manufacturers:

a. Same as manufacturer of metal channel (strut) framing system.

b. DeWalt "Bang-It" concrete inserts.

F. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

G. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

H. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.

2.8 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

I. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install hangers and supports in accordance with manufacturer's installation instructions.

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 22 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Division 22 Section "Plumbing Insulation" for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

    a. Uninsulated Copper Pipe: Install with plastic galvanic isolators

    b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".

    a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.

2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation". Do not use polymer-based shields for hot piping.

    a. Exception for horizontal cold-piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.

3. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

4. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

N. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".

O. Vertical Piping Risers:

1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for piping riser supports.

P. Wire Rope Hanging Systems:

1. Install in accordance with manufacturer's instructions.
2. Supported load shall not exceed manufacturer's recommended load rating.
3. Applications for Pipe Supports:
    a. 3 inch and smaller.
    b. Wire rope hanging system is not allowed for steam or steam condensate piping.
4. Do not support pipe by wrapping the rope around the pipe.
5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in Division 22 piping sections.
6. Install cast-in-place concrete inserts in elevated concrete slabs.
7. Install bream clamps for attachment to structural beams as required.

Q. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

R. Pre-Engineered Roof Pipe Supports: Set supports on an 18" X 18" x 3/16" thick roof walkway material compatible with the roof material.

3.4 INSTALLATION OF PIPE ALIGNMENT GUIDES

A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise. Install pipe insulation at guide to not interfere with movement of pipe within the guide.

B. Install guide to accommodate 1/2 the thermal movement at the adjacent expansion joint.

C. Anchor to building substrate.

3.5 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 INSTALLATION OF PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Install pre-engineered roof pipe supports to rest on the roofing membrane without attachment to the roof structure or penetration through the roofing assembly.

B. Install pre-engineered roof pipe supports anchored to the roof structure.

1. Install supports to meet the specified design criteria.

   a. Building Design Risk Category: II

   b. Design Wind Speed: 200 mph.

2. Coordinate with the pre-engineered roof pipe support manufacturer to anchor the pipe supports directly to the roof structure in accordance with the manufacturer's installation instructions or provide intermediate pipe supports engineered to meet the design criteria.

3. Submit design and installation requirements as a Deferred Submittal.

3.7 EQUIPMENT SUPPORTS

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

F. Secure fasteners according to manufacturer's recommended torque settings.

G. Remove temporary supports.

H. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

I. Grouting: Place grout under supports for piping and equipment.

3.8 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.9 FIELD QUALITY CONTROL

A. Examine support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section “Painting.”

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.10 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

C. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:

a. Band hanger.

b. Swivel split ring.

c. Clevis hanger.

2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.

3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.

4. All drainage pipe sizes: Clevis hanger.

D. Trapezes and Strut-mounted Supports:

1. All pipe sizes less than 6 inches: Two-piece clamp.

2. Pipe sizes 6 inches and greater: Roll support.

E. Wall Supports:

1. Pipe sizes 3 inches and less:

a. Two-hole strap mounted to wall.

b. Welded steel bracket with reinforced angle or strut.

2. Pipe sizes 4 inches and greater:

c. U-bolt

d. Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipe sizes 4 inches and less: Pipe saddle.

2. Pipe sizes 6 inches and greater: Roll support.

END OF SECTION 220529

SECTION 220548 - SEISMIC CONTROLS FOR PLUMBING SYSTEMS

PART 1 - GENERAL REQUIREMENTS

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 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 20 Section “Seismic Controls for MEPFTR Systems” for general requirement and related documents that apply to this section.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUMMARY

A. Seismic bracing, restraints, and controls for all plumbing systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEPFTR Systems”.

1.5 SUBMITTALS

A. Provide submittals as required by Division 20 Section “Seismic Controls for MEPFTR Systems” for all plumbing systems specified herein.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

B. Types of identification devices specified in this Section include the following:

1. Painted Identification Materials
2. Plastic Pipe Markers
3. Plastic Tape
4. Underground-Type Plastic Line Marker
5. Engraved Plastic-Laminate Signs
6. Plastic Equipment Markers
7. Plasticized Tags

1.2 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

D. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section “General Plumbing Requirements.”

1.4 SPARE PARTS

A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:

1. Advanced Graphic Engraving, LLC.
2. Brady Co.
3. Brimar Industries, Inc.
4. Craftmark.
5. Kolbi Pipe Marker Co.
6. Seton

2.2 PLUMBING IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications. Minimum letter height shall be 1-1/4" high letters for ductwork and 3/4" high letters for access door signs and similar operational instructions.

B. Stencil Paint: Stencil paint shall be exterior type, oil based, alkyd enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Identification paint shall be oil based, alkyd enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.4 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1

B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1

C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

2. Adhesive lap joint in pipe marker overlap.

3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

F. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.

G. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

2.5 PLASTIC TAPE

A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.6 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for plumbing fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.8 PLASTIC EQUIPMENT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:

1. Green: Cooling equipment and components.

2. Yellow: Heating equipment and components.

3. Yellow/Green: Combination cooling and heating equipment and components.

4. Brown: Energy reclamation equipment and components.

5. Blue: Equipment and components that do not meet any of the above criteria.

6. For hazardous equipment, provide colors and designs recommended by ANSI A13.1.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and plan number.

2. Equipment service.

3. Design capacity.

4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.9 PLASTICIZED TAGS

A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.10 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Application: Provide piping system identification for the following systems:

1. Natural gas piping.

C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Within 5 feet of each valve and control device.
2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

3.3 UNDERGROUND PIPING IDENTIFICATION

A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Meters, gauges, thermometers and similar units.
3. Pumps
4. Heat exchangers
5. Water heaters, tanks and pressure vessels.

6. Strainers, water treatment systems and similar equipment.

B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

1. Optional Use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceilings or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

2. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

END OF SECTION 220553

SECTION 227000 - NATURAL GAS SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:

1. Pipes, fittings, and specialties.
2. Special duty valves.
3. Pressure regulators.

B. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General plumbing Requirements," for trenching, excavation, backfill and compaction materials and methods for underground piping installations.
2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.
3. Division 9 Section "Painting," for materials and methods for painting pipe.
4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall and floor penetrations.
5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, unions, dielectric flanges, and mechanical sleeve seals.
6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting gas distribution piping.

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.

C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.

D. Point of Delivery: The outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.3 SUBMITTALS

A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Shop drawings detailing dimensions, required clearances, for connections to gas meter.

C. Coordination drawings for gas distribution piping systems in accordance with Division 22 Section "General Plumbing Requirements."

D. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

E. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

F. Test reports specified in Part 3 below.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."

C. Regulatory Requirements: Comply with the requirements of the following codes:

1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installation and inspections, testing, and purging of gas piping systems.
2. 2015 International Fuel Gas Code

D. Local Gas Utility Requirements: Comply with local gas utility installation rules and regulations.

E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.5 SPARE PARTS

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:

1. Gas Ball Valves – 2” and Smaller:
    a. Apollo Valves # 77F-1XX-01
    b. Hammond Valve # 8901
    c. Milwaukee Valve # BA-475B
    d. Nibco Inc. # T-FP 600A
    e. Watts # FBV-3C
2. Gas Ball Valves – 2-1/2” to 4”:
    a. Apollo Valve # 77F-1XX-01
    b. Hammond Valve # 8901
    c. Milwaukee Valve # BA-475B
    d. Nibco Inc. # T-FP 600A
3. Gas Cocks – 2” and Smaller:
    a. Homestead # 601
    b. Milliken #200M
    c. RM Energy Systems # D125
4. Gas Cocks – 2-1/2” and Larger:
    a. Homestead # 602
    b. Milliken #200MF
    c. RM Energy Systems “Hercules” # D126
5. Gas Pressure Regulators
    a. American Meter Company
    b. Fisher
    c. Itron
    d. Sensus
    e. Maxitrol
6. CSA Listed Gas Pressure Regulators
    a. Karl Dungs, Inc.
    b. Maxitrol
    c. Pietro-Fiorentini
7. Pre-sleeved Vent Capable Semi-rigid Corrugated Stainless Steel Tubing
    a. Omegaflex, Inc. TracPipe II
8. Polyethylene Pipe and Pipe Fittings:
    a. Cresline Plastic Pipe Co. PE 2708
    b. Charter Plastics PE 2708
    c. Chevron Phillips DriscoPlex Series 6500

d. JM Eagle “MDPE Yellow Gas”

9. Polyethylene to Steel Pipe Transition Fittings:
   a. Perfection Corporation
   b. R.W. Lyall
   c. Central Plastics
10. Seismic Gas Valves
   a. Faymakine
   b. Little Fire Fighter Gas Safety Products
   c. Pacific Seismic Products
11. Insect Screens
   a. Northtown Pipe Protection Products “BUGSCRN Series”
12. Gas Relief Vents
   a. Richards “GV Series”

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the specified pipe and fitting materials listed below are used.

B. Steel Pipe: ASTM A 53, Grade B, Schedule 40, (Type E electric-resistance welded or Type S seamless, black steel pipe, beveled ends).

C. Copper Tubing - Drawn Temper: ASTM B88, Type L.

D. Semi-rigid Corrugated Stainless Steel Tubing: Type 304 stainless tubing meeting ASTM A240, with UV resistant polyethylene jacket meeting ASTM E-84 flame and smoke rating and yellow brass auto-flare ends with stainless steel inserts.

E. Pre-sleeved Vent Capable Semi-rigid Corrugated Stainless Steel Tubing: Type 304 stainless tubing meeting ASTM A240, with UV resistant polyethylene jacket meeting ASTM E-84 flame and smoke rating, encased in a polyethylene ventable sleeve and yellow brass auto-flare ends with stainless steel inserts.

F. Plastic Pipe: Medium Density, SDR-11 iron pipe size polyethylene pipe, meeting ASTM D 2513, with heat fusion connections. Pipe shall meet Plastic Pipe Institute Material Designation of PE 2708.

2.3 FITTINGS

A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
   1. 1-1/4” and smaller shall be socket type
   2. 1-1/2” and larger shall be butt weld type.

C. Forged Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, butt weld ends, standard pattern with bolts, nuts and gaskets of material group 1.1.

D. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

E. Semi-rigid Corrugated Stainless Steel Tubing Mechanical Fittings: ANSI B16, yellow brass auto-flare ends with stainless steel inserts or double wall flare with Jacket Lock™, mechanical capture of the jacket and NPT male or female threaded ends, of the same manufacturer of the corrugated stainless steel tubing, tested and listed by CSA International for concealed use.

F. Semi-rigid Corrugated Stainless Steel Tubing Flanges: ANSI B16, yellow brass or malleable iron, of the same manufacturer of the corrugated stainless steel tubing, tested and listed by CSA International.

G. Plastic Fittings: Medium density polyethylene socket fusion fittings, meeting ASTM D 2513 compatible with the piping system.

H. Transition Fittings – Steel to Polyethylene: Factory assembled and pressure tested one piece design, with steel half of Schedule 40 steel pipe with beveled edge for welding and polyethylene half shall be of ample length for making welds. Steel pipe shall have epoxy protective coating.

I. Insect screens: Black steel body with 20 mesh stainless steel screen and MNPT end.

J. Gas Relief Vents: Galvanized steel body with 90 degree inlet to screened outlet, 20 mesh stainless steel screen and FNPT end.

2.4 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

B. Joint Compound: Suitable for the gas being handled.

C. Gasket Material: Thickness, material, and type suitable for gas to be handled, and for design temperatures and pressures.

2.5 PIPING SPECIALTIES

A. Seismic Gas Valves: Sinking ball or swing type for vertical or horizontal installation, UL listed, tested to ASCE 25 and ANSI Z21.21 with iron body, site gauge, threaded ends for 2 inch and smaller, flanged ends for 2-1/2” inch and larger with a 60 psig maximum operating pressure.

B. Protective Coating: When piping will be in contact with material or atmosphere exerting a corrosive action, pipe and fittings shall be factory-coated with polyethylene tape, having the following properties:

1. overall thickness; 20 mils;
2. synthetic adhesive;
3. water vapor transmission rate, gallons per 100 square inch: 0.10 or less.
4. water absorption, percent: 0.02 or less.
5. Prime pipe and fittings with a compatible primer prior to application of tape.

C. Strike Plates: 16 gauge carbon steel, tested and listed by CSA International.

D. In wall Strike Protection Hose: UL listed spiral wound interlocking galvanized steel reduced wall flexible conduit.

E. Nonmetallic Watertight Conduit: Schedule 80 rigid PVC, UL 651, with fittings to match to conduit type and material.

F. Multiple Port Manifolds: ANSI LC1b, plastic coated malleable iron, of the same manufacturer of the corrugated stainless steel tubing, tested and listed by CSA International.

2.6 BARBED TAPE – CONCERTINA RAZOR TAPE

A. Wire-Reinforced Tape: ASTM F 1910; continuous coil with four-point, needle-sharp barbs permanently cold clenched around a core wire.

1. Core Wire: High-tensile-strength, zinc-coated steel.
2. Configuration: Single coil.
3. Style: Concertina pattern.
4. Coil Diameter(s): 18-inch (457-mm)
5. Barb Length Classification: Meduim, 0.4-inch (10.2 mm) barb.
6. Barb Spacing: 4 inches (102 mm) o.c.

2.7 VALVES

A. Gas Ball Valves – 2” and Smaller: Full port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 600 WOG, UL listed for natural gas service.

B. Gas Ball Valves – 2-1/2” to 4”: Standard port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 400 WOG, UL listed for natural gas service.

C. Gas Cocks 2 Inch and Smaller: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body, brass or semi-steel plug with full area rectangular port, straightaway pattern, square head, threaded ends.

D. Gas Cocks 2-1/2 Inch and Larger: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body and plug with full area rectangular port, straightaway pattern, single gland, wrench operated, flanged ends.

E. Gas Line Pressure Regulators: Single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; internal relief vent, vent limiter for indoor installation, with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow as indicated on the drawings.

1. CSA listed for 2 PSI gas systems
2. CSA listed for 5 PSI gas systems with factory overpressure protection device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.3 PREPARATION FOUNDATION FOR UNDERGROUND GAS SERVICE PIPING

A. Pipe Beds for Pre-sleeved Vent Capable Semi-rigid Corrugated Stainless Steel Tubing, PE Pipe and PVC Pipe Conduit: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement or fusion process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase.

B. Refer to Division 22 Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

3.4 PIPE APPLICATIONS

A. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

B. Install Type L, hard-drawn copper tubing with wrought copper fittings and brazed joints for 2 inch and smaller, above ground, within building.

C. Install semi-rigid corrugated stainless steel tubing with yellow brass or malleable iron fittings and mechanical joints for 2 inch and smaller.

D. Install PE plastic pipe with fusion bond plastic fittings below grade outside the building slab.

E. Install pre-sleeved vent capable semi-rigid corrugated stainless steel tubing for single runs tubing underslab inside of building.

3.5 PIPING INSTALLATION

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: As specified below:

1. Inaccessible Above-Ceiling Locations: Install concealed gas piping in inaccessible above-ceiling spaces without valves or unions.

2. Accessible Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum. Valves and unions shall not be located in such spaces used as a plenum.

3. Piping In Partitions: Install concealed gas piping in hollow partitions with welded joint (subject to the approval of the authority having jurisdiction) and protect gas piping against physical damage. Install gas piping passing through partitions with no joints or unions inside the partition.

4. Concrete or Masonry Walls: Do not install gas piping in masonry or concrete walls.

5. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section “Common Work Results for Plumbing” for special sealers and materials.

E. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods” for special sealers and materials.

F. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 22 Section “Common Work Results for Plumbing” for additional information.

G. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section “Basic Piping Material and Methods” for additional information.

H. Dirt legs and Sediment Traps: Install a dirt leg at points where condensate and impurities may collect, at the outlet of the gas meter, as close to the inlet of each gas appliance or equipment as possible, and in a location readily accessible to permit cleaning and emptying.

1. Construct dirt legs and sediment traps using a tee fitting with the bottom outlet plugged or capped. Provide a 3” length of pipe and screwed cap for the dirt leg. Use line size pipe for dirt leg, refer to the drawings for sizes. Enter the tee with flow from the top and exit the tee from the side outlet. Install the dirt leg a minimum of 3-1/2” above the roof or floor readily accessible to permit cleaning and emptying.

2. Install line size gas cock, union and dirt leg at each equipment connection; refer to the drawings for sizes. Provide reducers at the equipment connection as required. Unions are specified in Division 22 section “Basic Piping Materials and Methods”.

I. Use fittings for all changes in direction and all branch connections.

J. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

K. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

L. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

M. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Allow sufficient space above removable ceiling panels to allow for panel removal.

N. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

O. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

P. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

Q. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

R. Install unions in pipes 2 inch and smaller, adjacent to each valve, and elsewhere as indicated. Unions are not required on flanged devices. Unions are specified in Section “Basic Piping Materials and Methods”.

S. Joints Containing Dissimilar Metals: Provide dielectric unions for 2” and smaller and dielectric flanges for piping 2-1/2” and larger. Dielectric unions and flanges are specified in Section “Basic Piping Materials and Methods”.

T. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

U. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

V. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."

W. Paint Exposed Outdoor Gas Piping: Cleaning and painting of exposed outdoor gas piping is specified in Division 9 Section "Painting".

1. Final color per the architect.

X. Semi-rigid Corrugated Stainless Steel Tubing:

1. Install through floors, walls and ceilings with an opening at least ½” larger than the outside diameter of the tubing.

2. Install changes in direction with a minimum bend radius per the manufacturer’s recommendations to avoid over stressing the tubing or fittings. Replace tubing that has been installed with tight bends, kinks, twists or stretches with new.

3. Provide striker plates within 3” of joist, ceiling, or floor and per the manufacturer’s recommendations to protect tubing installed beneath, or along floor support members or though floor support members to protect concealed piping from puncture.

4. Install tubing within partition walls between wall studs hanging freely and provide striker plates where the tubing is attached or constrained at studs or other retaining type structures to prevent the possibility of being punctured by a 3” long nails.

5. Install termination outlets with sufficient clearance from ceilings, walls and floors to permit the use of a suitably sized pipe wrench without straining or bending the tubing. Provide a strike plate or encase the tubing in a strike protection hose to protect the tubing where movement is restricted due to the termination outlet. Concealed fitting are permitted when the piping is installed within a strike protection hose.

6. Install manifolds in an accessible location.

7. Install tubing under concrete slab on grade within buildings provide with either factory installed pre-sleeved vent pipe or conduit at least ½” larger than the outside diameter of the tubing. Install tubing underslab as one piece, with no splices - concealed fittings are not permitted. Tubing is not permitted to be directly embedded within concrete.

8. Install tubing underground outside of building and provide with either factory installed pre-sleeved vent pipe or conduit at least ½” larger than the outside diameter of the tubing. Provide minimum burial depth of 18”. Install conduit to extend 12” minimum above grade. Install tubing underground as one piece, with no splices - concealed fittings is not permitted. Attach to the building or structure within 12” of entering or leaving conduit. Provide a support post where the building or structure is not available for support.

9. Provide a pipe sleeve at least ½” larger than the outside diameter of the tubing within 6 feet of floor / grade to protect exposed piping either inside building or outside building.

10. Fittings with auto-flare ends with stainless steel inserts: Provide shrink sleeves at mechanical joints and associated exposed metal tubing for protection from damage.

11. Fittings with double wall flare with Jacket Lock™, mechanical capture of the jacket: Secure jacket with fitting at mechanical joints. Where jacket is not captured by fitting, provide shrink sleeves at associated exposed metal tubing for protection from damage.

12. Provide transition fittings for steel to tubing in accessible location to permit visual inspection.

13. Tubing is not approved for installation as a gas appliance connector for final connection to movable gas appliances or equipment. Do not directly connect tubing to either movable or non-movable equipment or appliances.

14. Install tubing underslab inside of building with pre-sleeved vent capable semi-rigid corrugated stainless steel tubing. Provide minimum burial depth of 18”. Install tubing underground as one piece, with no splices - concealed fittings is not permitted. Extend to above slab 12” above floor at both ends.

    a. Provide copper tube vent with braised joints from vent connection in pre-sleeved vent capable semi-rigid corrugated stainless steel tubing to the outdoors where indicated on the drawings.

Y. Install plastic pipe underground with socket weld plastic joints. Use transition fittings for joining steel to plastic pipe. Installation and pipe bedding shall be per the manufacturer's published installation recommendations.

3.6 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for steel pipe 2-1/2" and larger for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

3. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual exposed runs on walls.

4. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube.

5. Provide roll hangers for individual horizontal runs 100 feet or longer.

6. Provide roll hangers for individual horizontal runs 20 feet or longer for exposed piping installed on roofs.

7. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58 and SP-69, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size in Inches	Max Span In Feet	Min. Rod Dia. - Inches
1/2	6	3/8
3/4 to 1	8	3/8
1-1/4 to 2	10	3/8
2-1/2 to 3	10	3/8
4	10	3/8
6	10	1/2
8	10	3/4

8. Support semi-rigid corrugated stainless steel tubing with the following maximum spacing:

Nom. Pipe Size in Inches	Max Horizontal Span - In Feet	Max Vertical Span - In Feet	Min. Rod Dia. - Inches
1/2	4	10	3/8
3/4	6	10	3/8
1 to 2	8	10	3/8

C. Support vertical piping at every floor.

D. Support gas piping within 12” of each elbow or tee and for gas piping 2-1/2” and larger at each valve or pressure regulator.

E. Support gas piping located on the roof with 4” x 4” x 12” long ACQ rot-proof treated timber blocks. Rot-proof timber blocks are specified in Division 22 Section "Hangers and Supports for Plumbing Piping”. Conform to the table above for maximum spacing of supports.

F. Support gas piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping”. Conform to the table above for maximum spacing of supports. Support pipe at a minimum 7” above the roof.

G. Support semi-rigid corrugated stainless steel tubing located on the roof with strut/channel from support to support, running parallel beneath the pipe.

H. Provide vibration isolation for piping connected to rotating equipment. Vibration isolators are specified in Division 22 specification Section “Vibration Isolation for Plumbing Piping and Equipment”.

I. PIPE JOINT CONSTRUCTION

J. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

K. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
2. CAUTION: Remove stems, seats, and packing of valves, and accessible internal parts of piping specialties before brazing.
3. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
4. Heat joints to proper and uniform temperature.

L. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.
2. Align threads at point of assembly.
3. Apply thread compound for use with gas systems to the external pipe threads.
4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

M. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.

Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

N. Fusion Welded: Joints shall be made by a qualified and approved operator in accordance with Title 49, CFR, Part 192.283 and be made in accordance with pipe manufacturer's recommendations.

O. Semi-rigid Corrugated Stainless Steel Tubing: Joints shall be made by a qualified and approved operator in accordance with pipe manufacturer's recommendations.

3.7 VALVE APPLICATIONS

A. General: The Drawings indicate valve types, locations, and arrangements.

B. Shut-off duty: Use gas cocks specified in Part 2 above.

3.8 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Install the emergency natural gas shutoff valve furnished with exhaust hood fire extinguishing system in an accessible location.

C. Install line size gas cock at the outlet of the gas meter set or gas riser and install a line size union downstream of the gas cock outside of the building.

D. Installation of Gas Pressure Regulators:

1. Install a gas cock 10 pipe diameters upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

2. Install line pressure regulators a minimum of 10 pipe diameters upstream of each atmospheric or power burner equipment connection.

3. Install line pressure regulators a minimum of 10'-0" upstream of each condensing boiler or water heater connection.

4. Install gas pressure regulator relief devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

5. Install gas pressure regulators with listed vent limiters indoors where allowed by the AHJ. Install with regulator dome vertically upright and level.

6. Install gas pressure regulators located outside the building with the relief port facing down to prevent the entry of moisture with the relief port a minimum of 18" above the roof or finish grade. Remove vent limiter and provide with line size (same size as gas vent relief port) insect screen or gas relief vent and 1" long schedule 40 black steel nipple.

   a. Where manufacturer does not allow the gas pressure regulator to be installed upside down, install gas pressure regulator with regulator dome in the horizontal or vertically upright with factory breather plug.

7. Gas Pressure Regulator Relief Vents: Provide for gas pressure regulators that require them or for vent less regulators where the AHJ requires them. Install steel

pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger. Route vent to the outdoors thru building side wall and turn down or thru the roof and turn down minimum 18" above the roof or grade. Provide with line size (same size as gas relief) insect screen or gas relief vent. Provide vent sizes per the following developed length and include 3 feet of length for each elbow:

a. 10 feet developed length = size vent one pipe size larger than relief vent outlet size

b. 20 feet developed length = size vent two pipe size larger than relief vent outlet size

c. 30 feet developed length = size vent three pipe size larger than relief vent outlet size

d. 40 feet developed length = size vent four pipe size larger than relief vent outlet size

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Install line size gas cock upstream and within 6 feet of gas appliance. Install a line size union or flanged connection downstream from the gas cock to permit removal of controls. Install reducer at the gas appliance connection, if required.

B. Install stainless steel flexible gas pipe connector, of size and length as required to complete equipment hook-up of foodservice equipment. Verify appropriate length of flexible gas pipe connector for movement of the foodservice equipment for cleaning.

3.10 ELECTRICAL BONDING AND GROUNDING

A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION 227000

SECTION 230010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Engineer in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA	Building Officials Code Administration
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer’s Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”

2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”

3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use. When ‘furnish’, ‘install’, ‘perform’, or ’provide’ is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Engineer, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Engineer”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

   a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

   b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Engineer.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the Engineer of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the Engineer has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate the work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work

of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Engineer. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.7 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time [or time specified in the Engineer's Agreement with the Client,] plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. Provide welders' qualification certificates.

N. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Engineer for Engineer's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Engineert's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.
    e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Engineer, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in each individual Section.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

A. Exposed ductwork and ferrous surfaces, including equipment stands and supports shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Engineer.

D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Insulation shall be effective.

3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Engineer or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.18 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.

2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced

polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.19 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.

2. Work in the existing building shall be scheduled with the Owner.

3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.

4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become their property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.

6. General Contractor shall install finish material.

7. Obtain permission from the Engineer for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in their bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 SELECTIVE DEMOLITION

A. Refer to Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.

a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.

F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.4 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Engineer prior to cutting. Do not cut or disturb structural members without prior approval from the Engineer and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Engineer and Structural Engineer prior to performing any work. Obtain approval from Engineer and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Engineer.

3.5 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.6 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections as required in each individual Section.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, the Contractor shall reimburse the Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 230010

SECTION 230015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Motor control centers	DIV26	DIV26	DIV26	DIV23t
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Overload heaters	DIV23m	DIV26	---	---
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV26	DIV26	DIV26	DIV23t
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Manual operating multi-speed switches	DIV23m	DIV26	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Time switches (for mechanical equipment)	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t
Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Pressure independent control valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Smoke dampers and combination fire/smoke dampers	DIV23m	DIV23m	DIV26	DIV28
Smoke dampers for smoke control system	DIV23t	DIV23m	DIV26	DIV23t/28
Control dampers	DIV23t	DIV23m	DIV26	DIV23t
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Refrigeration equipment and controls	DIV23m	DIV23m	DIV26	DIV23t
Pushbutton stations and connections	DIV23m	DIV23m	DIV26	DIV23t
Temporary heating connections	DIV23m	DIV23m	DIV26	DIV23m
Interlocks between air handling units and exhaust fans	---	---	---	DIV23m
Interlocks between HVAC fans and damper operators	---	---	DIV26	DIV23t

DIV23m = Mechanical Contractor
DIV23t = Temperature Controls Sub-Contractor
DIV26 = Electrical Contractor
DIV28 = Electronic Safety and Security

END OF SECTION 230015

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

B. Mechanical equipment nameplate data.

C. Concrete for bases and housekeeping pads.

D. Non-shrink grout for equipment installations.

E. Sleeves for mechanical penetrations.

F. Drip Pans with detection.

G. Miscellaneous metals for support of mechanical materials and equipment.

H. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.

I. Joint sealers for sealing around mechanical materials and equipment.

J. Sealing penetrations through noise critical spaces.

K. Plenum insulation for enclosure of combustible items located within fire-rated plenums.

L. Firestopping

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.

1. Product data for the following products:
    a. Access panels and doors.
    b. Joint sealers.
    c. Through and membrane-penetration firestopping systems.
    d. Plenum insulation.
2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
    a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

   a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

   1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.4 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

Space	RC Levels
Cells	25
Dayrooms	30

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

   1. Bar-Co., Inc.
   2. Elmdor Stoneman.
   3. JL Industries

4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
2. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
    a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wideexposed perimeter flange and adjustable metal masonry anchors.
    b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
3. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
    a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
4. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.2 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.4 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.5 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.6 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.7 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturers:

a. Dow Corning, Dowsil 790.

b. Dow Corning, Dowsil 795.

c. GE, Silglaze II SCS 2350.

d. GE, Silpruf SCS 2000.

e. Owens Corning, Energy Complete.

f. Pecora, 864 NST.

g. Tremco, Spectrem 1.

h. Tremco, Spectrem 2.

D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

1. Manufacturers:

a. Dow Corning, Dowsil 786.

b. GE, Momentum SCS1700.

c. Pecora, 898 Silicone NST.

E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.

1. Manufacturers:

a. BASF, MasterSeal NP 100.

b. Pecora, DyanTrol I-XL.

c. Tremco, Dymonic FC.

F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:

a. Pecora, AC-20

b. Sherwin Williams 950A

c. Tremco, Tremflex 834

2.8 ACOUSTICAL SEALANTS

A. General: Penetrations by ducts, pipes and conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

E. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90. Meeting ASTM E84 for a smoke flame spread index of less than 25 / 50.

F. Manufacturers:

1. Pecora, AC-20 FTR.
2. Pecora, AIS-919.
3. USG, SHEETROCK Acoustical Sealant.

2.9 PLENUM INSULATION

A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.

B. Material: Provide light weight, high temperature, inorganic fiber blanket enhanced for biosolubility and encapsulated with a scrim-reinforced foil.

C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

D. Physical Properties: Plenum insulation shall be single, minimum 1/2” thick layer with a density of 2 to 8 pounds per cubic foot.

E. Acceptable Manufacturers and Products:

1. 3M Fire Barrier Plenum Wrap 5A+.
2. ETS Schaefer Plenumshield Blanket.
3. Knauf Earthwool 1000^{o} Pipe Insulation with ECOSE Technology.
4. Morgan Advanced Materials – Thermal Ceramics FireMaster PlenumWrap+.
5. Owens Corning Pipe Insulation SSL II with ASJ Max Jacket.
6. Unifrax FyreWrap 0.5 Plenum Insulation.

2.10 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E814, or other NRTL acceptable to AHJ.

B. Manufacturers:

1. 3M Corp., Fire Barrier Sealant.

2. Hilti.
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR.
5. RectorSeal.
6. Specified Technologies Inc., Firestop.
7. USG SHEETROCK Firecode Compound.
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

3.2 INSTALLATION OF ACCESS DOORS

A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section "Identification for HVAC Piping and Equipment" for labeling of access doors.

B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

C. Access doors must be of the proper construction for type of construction where installed.

D. The exact location of all access doors shall be verified with the Architect prior to installation.

E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

F. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

A. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

C. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

F. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

K. All circular and oval openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section “Basic Piping Materials and Methods”. All rectangular openings through underground exterior walls shall be flanged and flashed with non-corrosive material on each side and the gap sealed with weatherproof sealant.

3.8 ACOUSTICAL PENETRATIONS

A. General: There shall be no direct contact of Sheet Metal or piping with shaft walls, floor slabs and/or partitions. All openings around pipes and ducts in the structure surrounding the mechanical equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein.. This includes all slab penetrations and penetrations of noise critical walls.

B. Duct Penetrations: Where each duct passes through a wall, floor or ceiling of a noise critical space, there shall be a clear annular space of 1 inch between the duct and structure. After all of the ductwork is installed, the Contractor shall check the clearance, pack the voids full depth with packing material and caulk both ends with non-hardening sealant backed by foam rod or permanently flexible firestop material. Where there is not sufficient access space to pack around all sides of a duct (for example, at the underside of a slab), place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

3.9 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1” perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer’s written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated plenums where the use of plenum insulation is not approved.

END OF SECTION 230500

SECTION 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Joining materials.

B. Escutcheons.

C. Nipples.

D. Unions.

E. Dielectric unions.

F. Dielectric waterway fittings.

G. Dielectric flanges and flange kits.

H. Mechanical sleeve seals.

1.2 SUBMITTALS

A. Refer to Division 01 and Division 23 Section “General Mechanical Requirements” for administrative and procedural requirements for submittals.

B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.

C. Quality Assurance Submittals: Submit welders' certificates specified in Article “Quality Assurance” below.

D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer’s catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).

E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

G. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.

H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

K. As-built drawings for each piping system in electronic and PDF format.

L. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.3 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section IX, "Welding, Brazing, and Fusing Qualifications."

B. Comply with ASME B31.9 - Building Services Piping, most recent edition.

C. Comply with American Welding Society (AWS), Welding Handbook, most recent edition.

D. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.

E. Pipe freeze protection system shall be listed and classified by Underwriter's Laboratories, Inc. as suitable for purpose intended.

F. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.

G. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Welding Materials: Comply with AWS D10.12 and Section II, Part C, ASME BPVC for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

D. Brazing Filler Metals: Comply with SFA-5.8, Section II, ASME BPVC for brazing filler metal materials appropriate for the materials being joined.

1. AWS A5.8, Classification BAg–5:
    a. Silver (Ag) 44.0 – 46.0 percent.
    b. Zinc (Z) 23.0 – 27.0 percent.
    c. Copper (Cu) 29.0 – 31.0 percent.
2. AWS A5.8, Classification BCuP–5:
    a. Phosphorus (P) 4.8 - 5.2 percent.
    b. Silver (Ag) 14.5 - 15.5 percent.
    c. Copper (Cu) remainder.

E. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.

F. Plastic Pipe Solvent Cement:

1. PVC: ASTM D2564.
2. CPVC: ASTM F493.

G. Gaskets for Flanged Joints: ASME B16.21, full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ASME Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.3 ESCUTCHEONS

A. Manufacturers:

1. AWI Manufacturing.

2. Keeney Manufacturing Company.

3. Wal-Rich Corp.

4. Jones Stephens Corp.

5. Approved equal.

B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.4 NIPPLES

A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

2.5 UNIONS:

A. Manufacturers:

1. Anvil International.

2. Hart Industries.

3. Mueller Streamline Co.

4. Victaulic Company of America.

5. Watts Regulator Co.

6. Approved equal.

B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

1. Malleable-iron: ASME B16.39, class as specified in section “Hydronic Piping” for the piping system used.

2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section “Hydronic Piping” for the piping system used.

3. Copper: ASME B16.22 wrought copper body.

a. For hydronic systems, provide class as specified in section “Hydronic Piping” for the piping system used.

b. For refrigerant systems, provide pressure rating as required for the refrigerant type used.

2.6 DIELECTRIC UNIONS

A. Manufacturers:

1. Hart Industries.

2. Victaulic Company of America.

3. Watts Regulator Co.

4. Approved equal.

B. Factory-fabricated with cast bronze body meeting ASTM B584 and galvanized or black steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.7 DIELECTRIC WATERWAY FITTINGS

A. Manufacturers:

1. .
2. Victaulic Company of America (Sweat and threaded connections only).
3. Approved equal.

A. Electroplated steel, brass, bronze, or nylon encapsulated nipple, with an inert and non-corrosive, thermoplastic lining, and appropriate end connections for the pipe materials in which installed (screwed, soldered, grooved, or flanged) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.8 DIELECTRIC FLANGES AND FLANGE KITS

A. Manufacturers:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Pipeline Seal & Insulator, Inc.
4. Tampa Rubber & Gasket Co. Inc.
5. Watts Water Technologies.
6. Approved equal.

B. Full-faced gasket with same outside diameter and bolt hole arrangement as the flange. Conform to ANSI B16.5. Pressure rating of 200 psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.

C. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

D. Flanges: Cast bronze meeting ASTM B584, class 125 solder type or cast iron meeting ASTM A536, class 125 threaded type for low pressure service, bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

2.9 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline/Link Seal.
2. Calpico, Inc.

3. Metraflex Co.

4. Approved equal.

B. Sleeves: Refer to Division 23 Section "Common Work Results for HVAC" for sleeve materials.

C. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations. Provide deep pattern escutcheons where required to conceal protruding pipe fittings.

D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

J. Verify final equipment locations for roughing in.

K. Use fittings for all changes in direction and all branch connections.

L. Remake leaking joints using new materials.

M. Install components with pressure rating equal to or greater than system operating pressure.

N. Piping Protection:

1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.3 PENETRATIONS

A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section “Common Work Results for HVAC” for additional penetration requirements.

B. Above Grade Concrete or Masonry Penetrations:

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.

a. Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

C. Underground, Exterior-Wall Penetrations:

1. Install cast-iron sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

2. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

D. Above Ground, Exterior Wall Penetrations:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

E. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron sleeves, extend top of sleeve minimum 1 inch above finish floor. Size sleeve for minimum 1/2 inch annular space between pipe and sleeve.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."

5. Extend bottom of sleeve below floor slab as required and secure underdeck clamp to hold sleeve rigidly in place.

F. Interior Foundation Penetrations:

1. Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

G. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

2. Provide 1/2 inch thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2 inches above and below the concrete slab.

H. Interior Penetrations of Non-Fire-Rated Walls:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

I. Fire / Smoke Rated Floor and Wall Assemblies:

1. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.

J. Acoustical Barrier Penetrations:

1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The internal diameter of the sleeve shall be minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.

2. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.4 PIPE JOINT CONSTRUCTION

B. Threaded Joints:

1. Provide tapered pipe threads for field cut threads. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full inner diameter.

3. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine how far pipe should be threaded into joint.

4. Align threads at point of assembly.

5. Apply appropriate tape or thread compound to the male pipe threads except where dry seal threading is specified.

6. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Tighten joint to leave not more than 3 threads exposed.

7. Damaged Threads: Do not use pipe or pipe fittings with threads which are corroded or damaged.

C. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned.
3. Align flanges surfaces parallel.
4. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.
5. Use suitable lubricants on bolt threads.
6. Tighten bolts gradually and uniformly using torque wrench.

D. Welded Joints:

1. Comply with the requirement in ASME Code B31.9, "Building Services Piping."
2. Damaged Welds: Do not use pipe sections that have cracked or open welds.

E. Brazed and Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
3. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
4. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
1. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.
2. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
5. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
6. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.
7. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.
8. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
9. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

B. Mechanical Refrigerant Pipe Joints: Flared compression fittings may be used for refrigerant lines 3/4 inch and smaller.

F. Socket Joints:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

2. Prepare surfaces to be solvent cemented by wiping with a clean cloth moistened with acetone or methylethyl keytone.

3. CPVC Joints: Solvent cement joints in accordance with ASTM D2846.

4. PVC Joints: Solvent cement joints in accordance to ASTM D2672.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.5 UNIONS

A. Install unions on pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

3.6 DIELECTRIC UNIONS

A. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

2. Install waterway fittings where installation is concealed. Do not install dielectric unions in concealed spaces.

3.7 DIELECTRIC WATERWAY FITTINGS

A. Install dielectric waterway fittings for piping 2 inch and smaller for copper or brass pipe connections to carbon steel equipment connections.

3.8 DIELECTRIC FLANGES AND FLANGE KITS

A. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

2. Install waterway fittings where installation is concealed. Do not install dielectric flanges in concealed spaces.

C. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

D. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

E. Provide full face gasket with pressure rating equal to system served.

F. At each bolt provide steel washers, thermoplastic washers, and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.9 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION 230510

SECTION 230513 - COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

F. Capacitors.

1.2 SUBMITTALS

A. Conform with the submittal procedures in Division 01.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70 National Electrical Code.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 DELIVERY STORAGE AND HANDLING.

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.5 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Baldor Electric Company.

B. General Electric.

C. Gould.

D. Marathon.

E. Regal-Beloit Corporation (Century).

F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.

B. Construction:

1. Open drip-proof except where noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Motors with frame sizes 254T and larger: Energy Efficient Type.

C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 APPLICATIONS

A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer’s standard and need not comply with these specifications.

B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

C. Single phase motors for fans, pumps, blowers and air compressors: Capacitor start type.

D. Motors located in exterior locations, air cooled condensers, humidifiers and explosion proof environments: Totally enclosed fan cooled type.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 26 - Motor Controlling Equipment.

K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: To NEMA MG 1.

M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.

N. Motors controlled by variable frequency drives:

1. Rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.

2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

3. Inverter-Duty Motors: Class B temperature rise; Class F insulation.

4. Shaft Bearing Protection:

   a. Provide shaft grounding system as listed below. Install system in accordance with manufacturer's recommendations.

      1) AEGIS SGR Bearing Protection Ring,

      2) Inpro/Seal Current Diverter Ring (CDR).

      3) Helwig Carbon Products BPK.

   b. Provide magnetic core as listed below. Install system in accordance with manufacturer's recommendations.

      1) VLT MCC 105.

      2) CoolBLUE Inductive Absorbers.

5. Motor Overload Relay: When a single drive is used to supply power to multiple motors, provide a solid state 3-phase adjustable overload relay between the drive and each motor.

   a. Relay shall have manual reset.

   b. Provide alarm contact with automatic reset overloads.

O. Part Winding Start, Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

P. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

Q. Nominal Efficiency: Motors shall have minimum NEMA premium efficiency at full load and rated voltage when tested in accordance with IEEE 112.

R. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.7 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.8 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnated.
5. Craft tissue insulation.
6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	84	73
2	1200	184T	85.5	75
3	1200	213T	86.5	60
5	1200	215T	87.5	65
7-1/2	1200	254T	88.5	73
10	1200	256T	90.2	74
15	1200	284T	90.2	77
20	1200	286T	91	78
25	1200	324T	91.7	74
30	1200	326T	92.4	78
40	1200	364T	93	77
50	1200	365T	93	79
60	1200	404T	93.6	82
75	1200	405T	93.6	80
100	1200	444T	94.1	80
125	1200	444T	94.1	84
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
10	1800	215T	89.5	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91.7	85
30	1800	286T	92.4	88
40	1800	324T	93	83

50	1800	326T	93	85
60	1800	364T	93.6	88
75	1800	365T	94.1	88
100	1800	404T	94.1	83
125	1800	405T	94.5	86
150	1800	444T	95	85
200	1800	445T	95	85
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88
10	3600	213T	88.5	86
15	3600	215T	89.5	89
20	3600	254T	90.2	89
25	3600	256T	91	92
30	3600	284T	91	91
40	3600	286T	91.7	92
50	3600	324T	92.4	89
60	3600	326T	93	91
75	3600	364T	93	88
100	3600	365T	93	88

3.4 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85.5	65
2	1200	184T	86.5	68
3	1200	213T	87.5	63
5	1200	215T	87.5	66
7-1/2	1200	254T	89.5	68
10	1200	256T	89.5	75
15	1200	284T	90.2	72
20	1200	286T	90.2	76
25	1200	324T	91.7	71
30	1200	326T	91.7	79
40	1200	364T	93	78
50	1200	365T	93	81
60	1200	404T	93.6	83
75	1200	405T	93.6	80

100	1200	444T	94.1	83
125	1200	445T	94.1	85
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	89.5	85
10	1800	215T	89.5	84
15	1800	254T	91	86
20	1800	256T	91	85
25	1800	284T	92.4	84
30	1800	286T	92.4	86
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	87
75	1800	365T	94.1	87
100	1800	405T	94.5	86
125	1800	444T	94.5	87
150	1800	445T	95	88
200	1800	447T	95	87
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	182T	85.5	87
5	3600	184T	87.5	88
7-1/2	3600	213T	88.5	86
10	3600	215T	89.5	86
15	3600	254T	90.2	91
20	3600	256T	90.2	89
25	3600	284T	91	92
30	3600	286T	91	92
40	3600	324T	91.7	91
50	3600	326T	92.4	92
60	3600	364T	93	93
75	3600	365T	93	91
100	3600	405T	93.6	92

END OF SECTION 230513

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal piping hangers and supports.

C. Saddles and shields.

D. Vertical piping clamps.

E. Pipe alignment guides.

F. Pipe anchors.

G. Anchors and fasteners.

H. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. Manufacturer's 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.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.6 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

1.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test fluid. Include the weight of the pipe, valves, insulation and piping accessories.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.2 SUPPORT AND ATTACHMENT COMPONENTS

B. General Requirements:

1. Comply with MSS SP-58.

2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.

3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

a. Indoor Dry Locations: Provide painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

a. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.

b. Natatorium or other treated pool environments: Type 316 stainless steel.

b. Outdoor Locations: Galvanized steel or Type 304 stainless steel.

c. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.

d. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

e. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

f. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.

C. Metal Channel (Strut) Framing Systems:

1. Manufacturers:

a. Cooper B-Line.

b. Ferguson Enterprises/FNW.

c. PHD Manufacturing.

d. Thomas & Betts Corporation.

e. Unistrut, a brand of Atkore International Inc.

f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-58, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:

a. Indoor Dry Locations: Provide carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel .

b. Indoor Damp or Wet Locations: Galvanized steel or Type 304 stainless steel.

c. Outdoor Locations: Galvanized steel or Type 304 stainless steel.

d. Natatorium or other treated pool environments: Type 316 stainless steel.

e. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

D. Hanger Rods:

1. Material:

a. Indoor Dry Locations: Zinc-plated steel.

b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.

c. Natatorium or other treated pool environments: Type 316 stainless steel.

2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.

4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

E. Wire Rope Pipe Hanging Systems:

1. Manufacturers:

a. ASC Engineered Solutions.

b. Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.

4. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.

5. Cable Stud: Carbon steel, zinc-coated, designed for attachment to concrete inserts. Model: ASC Engineered Solutions C120.

6. Cable Coupling: Carbon steel, zinc-coated, designed for attachment to threaded rods. Model: ASC Engineered Solutions C130.

7. Cable Eyelet: Carbon steel, zinc-coated, designed to be directly attached to structural supports via anchors or fasteners. Model: ASC Engineered Solutions C150.

8. Cable Toggle: Carbon steel, zinc-coated, with toggle designed for insertion into 1/2 inch hole through steel deck hat channel and provides anchor when pulled in tension. Model: ASC Engineered Solutions C160.

9. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.

10. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.

11. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. Armacell.

2. ASC Engineered Solutions.

3. Cooper B-Line, Inc.

4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy
6. Ferguson/FNW.
7. Halfen-DEHA.
8. Hilti.
9. National Pipe Hanger Corporation.
10. PHD Manufacturing.
11. Piping Technology and Products, Inc.
12. Power-Strut.
13. Unistrut.

B. Single Hangers:

1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
2. Split Ring: Carbon steel, adjustable swivel, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.
4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:
   a. ASC Engineered Solutions.
   b. Holdrite.
   c. Klo-Shure.
2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Spring Hangers:

1. Reference Section “Vibration Isolation for HVAC” for spring isolation hangers.

F. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

G. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

H. Pre-Insulated Supports:

1. Manufacturers:

a. Aeroflex USA, Inc.

b. Armacell.

c. ASC Engineered Solutions

d. Buckaroos, Inc.

e. Cooper B-Line, Inc.

f. Pipe Shields, Inc.

2. General Construction and Requirements:

a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.

b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

c. Waterproof calcium silicate insulation shall conform to ASTM C795.

d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.

e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.

3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Manufacturers: Same as hanger and Supports.

2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.

B. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.

2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.

4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft) 5	6	7	8	9	10
	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
≤ 1	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
≤ 2	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

C. 360 Degree Insulation Protection Shield:

1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Plastic Saddles and Shields:

1. Manufacturers:

   a. Armacell.

   b. Eaton.

   c. Hydra-Zorb.

   d. PHD Manufacturing.

   e. Zsi Foster.

2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.4 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.

2. Cooper B-Line, Inc.

3. Halfen-DEHA.

4. Hilti.

5. ERICO/Michigan Hanger Co.

6. National Pipe Hanger Corporation.
7. PHD Manufacturing.
8. Piping Technology and Products, Inc.
9. Power-Strut.
10. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.
2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:
   a. Hydra-Zorb; Titan Riser Clamp.
   b. National Pipe Hanger.
   c. Pipe Hangers, Inc.
2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.5 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.
2. Pipe Diameter 10 inches and Larger: Roller type.
3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.6 PIPE ANCHORS

A. Pre-Insulated Anchors: Galvanized steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.

B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.7 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:
    a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
    b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.
2. Channel Material: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.
5. Manufacturers:
    a. Same as manufacturer of metal channel (strut) framing system.
    b. DeWalt “Bang-It” concrete inserts.

D. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

1. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Vibration Isolation Anchors: Reference Section "Vibration Isolation for HVAC" for vibration isolation anchors.

2.8 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

I. Provide vibration isolators at hangers and supports where specified in Section “Vibration Isolation for HVAC”.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 23 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Section “HVAC Insulation” for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
2. Where strut systems are attached to walls, install anchor bolts per manufacturer’s recommendations.
    a. Uninsulated Copper Pipe: Install with plastic galvanic isolators

b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Section "HVAC Insulation".

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamp to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section "HVAC Insulation".

a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert.

2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

a. If insulation protection shields are used instead of protection saddles on hot piping where vapor barrier is not required, provide high density insulation insert sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation".

3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.

a. Exception for 2 inch and smaller horizontal piping with cellular glass, flexible elastomeric, or polyisocyanurate insulation: High density insulation insert is not required. Provide insulation protection shield over the insulation with length specified for pipe size and insulation thickness to prevent puncture or other damage.

4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

P. Vertical Piping Risers:

1. Reference Section "Vibration Isolation for HVAC" for piping riser supports.

Q. Wire Rope Hanging Systems:

1. Install in accordance with manufacturer's instructions.

2. Supported load shall not exceed manufacturer's recommended load rating.

3. Applications for Pipe Supports:

a. 3 inch and smaller.

b. Wire rope hanging system is not allowed for steam or steam condensate piping.

4. Do not support pipe by wrapping the rope around the pipe.

5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in the Pipe Hanger and Support Schedule.

6. Install cast-in-place concrete inserts in elevated concrete slabs.

7. Install bream clamps for attachment to structural beams as required.

3.4 INSTALLATION OF PIPE ALIGNMENT GUIDES

A. Install pipe alignment guides at the following locations:

1. On piping that adjoins expansion joints, as required by expansion joint manufacturer. Install guide to accommodate 1/2 the thermal movement at the adjacent expansion joint.

2. Where roller hangers are required per Pipe Hanger and Support Schedule.

3. Elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems.

B. Install guides per ASME B31.9 unless noted otherwise.

C. Install pipe insulation at guide to not interfere with movement of pipe within the guide.

D. Anchor to building substrate.

3.5 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 EQUIPMENT SUPPORT AND ATTACHMENT

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

F. Secure fasteners according to manufacturer's recommended torque settings.

G. Remove temporary supports.

H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.

I. Grouting: Place grout under supports for piping and equipment.

3.7 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.8 FIELD QUALITY CONTROL

A. Examine support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section “Painting.”

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.9 PIPE HANGER AND SUPPORT SCHEDULE

A. Additional hanger and support requirements are in Sections specifying piping systems and equipment.

B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

C. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:
   a. Band hanger.
   b. Swivel split ring.
   c. Clevis hanger.
2. Cold and Hot pipe sizes 2 inches and greater where pipes are in stationary position: Clevis hanger.

3. Cold and Hot pipe sizes 2 inches and greater for pipes in the following locations: Roll support hanger.

   a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.

   b. Between anchor locations shown on the drawings.

D. Trapezes and Strut-mounted Supports:

1. Pipes in stationary position: Two-piece clamp, strut clamp or U-bolts.

2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.

   a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.

   b. Between anchor locations shown on the drawings.

E. Wall Supports:

1. Pipe sizes 3 inches and less:

   a. Two-hole strap mounted to wall.

   b. Welded steel bracket with reinforced angle or strut.

2. Pipe sizes 4 inch and greater:

   a. U-bolt.

   b. Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipes in stationary position: Pipe saddle.

2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.

   a. Axial movement due to thermal expansion or contraction is greater than one inch.

   b. Between anchor locations shown on the drawings.

END OF SECTION 230529

SECTION 230548 - SEISMIC CONTROLS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

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 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 20 Section “Seismic Controls for MEPFTR Systems” for general requirement and related documents that apply to this section.

1.3 DEFINITIONS

A. The IBC: 2015 International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 SUMMARY

A. Seismic bracing, restraints, and controls for all mechanical systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEPFTR Systems”.

1.5 SUBMITTALS

A. Provide submittals as required by Division 20 Section “Seismic Controls for MEPFTR Systems” for all mechanical systems specified herein.

PART 2 - PRODUCTS AND MATERIALS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive-backed duct markers.

D. Stencils.

E. Pipe markers.

F. Ceiling tacks.

G. Engraved plastic-laminate signs.

1.2 SUBMITTALS

A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:

1. Valve tag number.
2. Piping system and system abbreviation as shown on tag.
3. Location of valve (room or space).
4. Variations for identification (if any).
5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.
6. Valve manufacturer's name and model number.

C. Product Data: Submit manufacturer's technical product data for each product required.

D. Manufacturer’s Installation Instructions: Indicate special procedures and installation for each product required.

1.3 SPARE PARTS

A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.

B. Furnish not less than 3 additional numbered valve tags for each piping system.

C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Advanced Graphic Engraving, LLC.

B. Brady Corporation.

C. Brimar Industries, Inc.

D. Craftmark.

E. Industrial Safety Supply Co., Inc.

F. Kolbi Pipe Marker Co.

G. MIFAB, Inc.

H. Seton Identification Products, a Tricor Direct Company..

2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

A. General:

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.

2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).

B. Air Handling Units: Nameplates, stencils, or engraved plastic laminate signs.

C. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.

D. Control Panels: Nameplates.

E. Dampers: Ceiling tacks where located above lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.

F. Ductwork: Adhesive-backed duct markers. Stencils are only acceptable for concealed ductwork, exterior ductwork, or in mechanical rooms.

G. Fans: Nameplates, stencils, or engraved plastic laminate signs.

H. Instrumentation: Tags.

I. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.

J. Thermostats: Nameplates.

K. General Signs: Engraved plastic laminate signs.

2.3 NAMEPLATES

A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and mark number.
2. Equipment service.
3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.

C. Letter Color: White.

D. Letter Height: 1/4 inch.

E. Background Color:

1. Cooling equipment: Green.
2. Heating equipment: Yellow.
3. Combination cooling and heating equipment: Yellow/Green.
4. Energy reclamation equipment: Brown.
5. Hazardous equipment: Colors and designs recommended by ASME.
6. Equipment and components that do not meet any of the above criteria: Blue.

F. Plastic: Conform to ASTM D709.

2.4 TAGS

A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

C. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.

D. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass

grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).

E. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.

F. Valve Tag Chart: Typewritten letter size list in anodized aluminum or finished hardwood frame, covered with SSB-grade sheet glass. Provide frame and mounting screws for removable mounting.

G. Letter Height:

1. System Abbreviation: Minimum 1/4 inch.
2. Valve Number: Minimum 1/2 inch.

2.5 ADHESIVE-BACKED DUCT MARKERS

A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual label.

C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.

D. Specialty Exhaust: Identify the specialty using the system terminology (e.g., Grease, Dishwasher, Dryer, Fume Hood, etc.).

E. Color: Yellow background with black lettering or blue background with white lettering.

1. Hazardous Exhaust: Use colors and designs recommended by ASME A13.1.

2.6 STENCILS

A. Stencils: With clean cut symbols and letters of following size, complying with ASME A13.1:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
6. Ductwork and Equipment: 2-1/2 inch high letters.
7. Access Doors: 3/4 inch high letters.
8. Operational Instructions: 3/4 inch high letters.

9. Provide arrows indicating direction of flow.

B. Stencil Paint: Oil based, alkyd enamel, either brushing grade or pressurized spray-can form and grade, black color, except for piping. For piping systems use colors conforming to ASME A13.1.

2.7 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color:

1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.
3. Heating/Cooling Valves: Blue.

2.8 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:

1. Name and mark number.
2. Equipment service.
3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Install products in accordance with manufacturer's instructions.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Install tags on piping 3/4 inch diameter and smaller.

E. Install in clear view and align with axis of piping.

F. Apply stencil painting in accordance with Division 09.

G. Identify service, flow direction, and pressure.

3.3 DUCTWORK IDENTIFICATION

A. Install identification on the most obviously visible portion of the duct from the point of access.

B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:

1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.
3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.
5. Within 5 feet of equipment outlets and other points of origin or termination.
6. Install marker on the most obviously visible portion of the duct from point of access.

3.4 ACCESS DOOR IDENTIFICATION

A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.

B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.5 CEILING TACK INSTALLATION

A. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.6 EQUIPMENT IDENTIFICATION

A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:

1. To distinguish between multiple units in close proximity.
2. To inform operator of operational requirements.
3. To indicate safety and emergency precautions.
4. To warn of hazards and improper operations.

B. Adjust lettering size based on viewing distance from normal location of identification:

1. Less than 2 feet: Minimum 1/4 inch.
2. Up to 6 feet: Minimum 1/2 inch.
3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.

C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General testing, adjustment, and balancing requirements.

B. Pre-testing, adjustment, and balancing of existing air systems.

C. Testing, adjustment, and balancing of air systems.

D. Sound and vibration measurement of equipment operating conditions.

E. This section excludes:

1. Testing boilers and pressure vessels for compliance with safety codes;
2. Specifications for materials for patching mechanical systems;
3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
4. Requirements and procedures for piping and ductwork systems leakage tests.

1.2 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

H. Main: Duct or pipe containing the major or entire fluid flow of the system.

I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.

J. Branch main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.3 SUBMITTALS

A. Qualifications:

1. Submit qualifications of TAB agency.

2. Submit qualifications of TAB supervisor.

3. Submit qualifications of the smoke control system inspector.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

E. Progress Reports.

F. Certified TAB Reports:

1. General:

a. Submit within two weeks after completion of testing, adjusting, and balancing.

b. Revise TAB plan to reflect actual procedures and submit as part of final report.

c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:

a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.

b. The report reflects an accurate representation of how the systems have been installed.

c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.

d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.

4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:

    a. General Information and Summary

        1) Include project name, location, altitude, and date.

        2) Identify TAB agency, contractor, owner, architect, and engineer.

        3) Include addresses, contact names, and telephone numbers.

        4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.

        5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.

    b. Air Systems

    c. Temperature Control Systems

    d. Special Systems

    e. Sound and Vibration Systems

5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.

6. Units of Measure: Report data in I-P (inch-pound) units only.

G. Smoke Control System Test Report: A complete report of the testing and verification of the smoke control system shall be prepared by the special inspector or special inspection agency and submitted for approval. A copy of the final, approved report shall be submitted to the local fire code official and Owner.

H. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

1.4 QUALITY ASSURANCE

A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter “Testing, Adjusting, and Balancing”, most current edition.

C. TAB Agency Qualifications:

1. Act as the single source of responsibility for TAB of the HVAC systems.

2. Staff the project at all times by qualified personnel.

3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.

4. Certified by one of the following Certification Associations:

    a. AABC (NSTSB): Associated Air Balance Council, National Standards for Total System Balance.

b. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

c. TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.

D. TAB Supervisor and Technician Qualifications:

1. Certified by the same organization as TAB agency.

2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

E. Pre-Qualified TAB Agencies:

1. AccuTech

2. Doyle Field Services.

3. Precisionaire of the Midwest.

4. Pro Balance.

5. Total Air Balance.

PART 2 - PRODUCTS AND MATERIALS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.

B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.

C. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

D. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.

E. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

F. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.

G. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.

H. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

I. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Motors and bearings are lubricated.
5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
6. Duct systems are clean of debris.
7. Fans are rotating correctly and belts have tension.
8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Volume dampers are installed at locations needed for balancing the air systems.
11. Access doors are closed and duct end caps are in place.
12. Air outlets are installed and connected.
13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
14. Hydronic systems are flushed, filled, and vented.
15. Hydronic systems are tested for leaks.
16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.
17. Pumps are rotating correctly.
18. Proper strainer baskets are clean and in place.
19. Service and balance valves are open.
20. Expansion tanks are not air bound and have appropriate charge.
21. Air vents are operating freely.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.

B. Furnish all instruments required for testing, adjusting, and balancing operations.

1. Verify all instruments have been calibrated.
2. Furnish instruments as recommended by the manufacturer for the TAB application.
3. Furnish instruments that are best suited to the function being measured.
4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.

D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

F. Determine best locations in main and branch ductwork for most accurate duct traverses.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.

B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

3.5 RECORDING AND ADJUSTING

A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.

B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:

1. Dry bulb temperature.
2. Relative humidity.
3. Cloud cover.
4. Wind speed.
5. Time.

C. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

D. Ensure recorded data represents actual measured or observed conditions.

E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.

J. Seal ducts and piping and test and repair leaks.

K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

M. Check and adjust systems approximately six months after final acceptance and submit report.

N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.

O. Take all readings at eye level of the indicated value to prevent parallax.

P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

Q. Take measurements in the system where best suited for the task.

R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.6 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING AIR SYSTEMS

A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested

systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. TAB Contractor:

1. Measure and record the operating speed, airflow, and total and external static pressure of each fan system. Provide individual pressure drop readings across all coils, filter banks, dampers and other internal fan system components
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. For variable air volume systems: Open automatic air dampers to full design position to simulate a design day. Measure and record the operating speed and airflow of each fan system for full load conditions.
8. Report on the results of the measurements taken and any deficiencies.

C. Mechanical Contractor:

1. Check the refrigerant charge.
2. Report on the operating condition of the equipment and any deficiencies.

3.7 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Check filters for cleanliness.

B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.

C. Verify volume dampers are installed at locations needed for balancing the air systems.

D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

E. Determine best locations in main and branch ductwork for most accurate duct traverses.

F. Place outlet dampers in the full open position.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

H. Lubricate all motors and bearings.

I. Check fan belt tension.

J. Check fan rotation.

K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.

L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

M. Measure air quantities at air inlets and outlets.

N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.

P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.

V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.

W. Multi-Zone units with Mixing Dampers: Check for motorized damper leakage. Adjust air quantities with mixing dampers set first at design cooling, then at design heating.

X. For variable air volume boxes, set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

Y. On fan powered VAV boxes, adjust air flow switches for proper operation.

Z. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:

1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.

2. Operate supply fan at design speed and measure the outdoor airflow.

3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.

4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.

5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.

6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.8 TESTING FOR SOUND AND VIBRATION

A. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards:

1. ASHRAE: ASHRAE Handbook, HVAC Applications Volume, Chapter "Sound and Vibration Control", most current edition.

B. Other than sound data, failure of an item includes a deviation of more than 10 percent from setpoint. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.

1. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

C. Prepare and submit report of recommendations for correcting any sound or vibration levels that are outside of manufacturer's tolerances, ASHRAE standards and/or values specified in the contract documents.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping Insulation.

B. External Ductwork Insulation.

1.2 RELATED REQUIREMENTS

A. Division 23 Section “Metal Ducts” for duct liner insulation.

1.3 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.

C. Cold Duct: Ductwork that carries airflow with a minimum operating temperature less than 65 degrees F temperature.

D. Hot Duct: Ductwork that carries airflow with a minimum operating temperature greater than 75 degrees F temperature.

E. Neutral Ductwork: Ductwork that carries airflow with temperatures between the defined cold and hot temperatures.

F. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.

G. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.

H. Exposed: Insulation that is visible from the occupied space.

I. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.

J. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.

K. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

1.4 SUBMITTALS

A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.

B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1. Exception: Exterior mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.7 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 PIPING INSULATION MATERIALS

A. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.

b. Armacell LLC.

c. K-Flex USA.

2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.

   a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

   b. Minimum Service Temperature: Minus 297 degrees F

   c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

3. Factory Applied Jacket:

   a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.

B. Field-Applied Jacket:

1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

2. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.

   a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.

   b. Manufacturers:

      1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers

      2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.

      3) Or approved equal.

3. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in) Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco
≤ 36	0.032	0.020	See Note 1
> 36	0.040	0.024	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

   a. Banding:

      1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.

      2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.

b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.

5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.

b. Puncture Resistance: Minimum 15 pounds per ASTM D1000.

6. Interior Vapor Barrier Membrane: Multi-ply, composite membrane of aluminum foil with polyester films on each side to protect the aluminum foil. Membrane shall be reversible to provide a clean, white finish on one side or smooth silver finish on the other side. Provide Polyguard Products, Inc. ZeroPerm or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.

b. Puncture Resistance: Minimum 10 pounds per ASTM D1000.

C. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.

D. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.

2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.

4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02
Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.

5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

E. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

F. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

G. High Density Insulation Billets:

1. Calcium Silicate: ASTM C533 and C795.
2. Flexible elastomeric: ASTM C534, Type 1.
3. Polystyrene: ASTM C578, Type XIII.
4. Phenolic: ASTM C1126, Type III, Grade 1.

2.2 EXTERNAL DUCTWORK INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
   a. CertainTeed Corp.
   b. Johns Manville.
   c. Knauf Insulation.
   d. Owens Corning.
2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.
   a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
   b. Minimum Service Temperature: Minus 20 degrees F
   c. Maximum Service Temperature: 450 degrees.
   d. Density:
      1)
      2) 1.5 pounds per cubic foot.
3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
   a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.
   b. Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.
   c. Color: [White][Black].

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
   a. Johns Manville.
   b. Knauf Insulation.
   c. Owens Corning.
2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.

b. Minimum Service Temperature: 0 degrees F

c. Maximum Service Temperature: 450 degrees.

d. Density:

1) 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.

b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.

c. Polypropylene Scrim Polyester (PSP): Polyester paper with glass fiber yarn and bonded to polypropylene, water vapor permeance of 0.02 perms.

d. Color: White.

C. Cellular Glass:

1. Manufacturers:

a. Owens Corning.

2. Insulation: ASTM C552, Type I, Grade 6, rigid closed glass cells, block form.

a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.

b. Minimum Service Temperature: Minus 450 degrees F.

c. Maximum Service Temperature: 800 degrees F.

d. Density: Minimum 6 pounds per cubic feet.

D. Polyisocyanurate:

1. Manufacturers:

a. Dyplast Products.

b. Johns Manville.

c. Approved equal.

2. Insulation: ASTM C591, Grade 2, Type IV for ASTM E84 25/50 compliance, Type I for ASTM E84 25/450 compliance; rigid board.

a. K-value: ASTM C518 or C177, maximum 0.2 at 75 degrees F.

b. Minimum Service Temperature: Minus 297 degrees F

c. Maximum Service Temperature: 300 degrees F.

d. Density: Maximum 6 pounds per cubic feet.

E. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.

b. Armacell LLC.

c. K-Flex USA.

2. Insulation: ASTM C534, Grade 1, flexible elastomeric cellular rubber insulation, sheet form.

   a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

   b. Minimum Service Temperature: Minus 40 degrees F

   c. Maximum Service Temperature: 180 degrees F.

3. Factory Applied Jacket:

   a. Flexible Metal Cladding: Metallic factory-laminated cladding, 17.5 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.00 perms. Provide ArmaTuff or equal. Reference Duct Jacket Schedule in Part 3 of this specification for application of this jacket.

F. Polyolefin:

1. Manufacturers:

   a. K-Flex

   b. Sekisui Voltek

2. Insulation: ASTM C1427, Type II, physically crosslinked closed cell polyolefin foam, pre-formed for the application.

   a. K-value: ASTM C518, maximum 0.22 at 75 degrees F.

   b. Minimum Service Temperature: Minus 112 degrees F.

   c. Maximum Service Temperature: 212 degrees F.

   d. Density: Maximum 1.5 pounds per cubic feet.

3. Factory Applied Jacket: ASTM C1136, Type I.

   a. Reinforced aluminum foil with acrylic adhesive backing, water vapor permeance of 0.002 perm-in in accordance with ASTM E96.

   b. Heavy duty multilayer composite with UV resistance and salt resistant coating.

G. Field-Applied Jacket:

1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.

   a. Thickness: 0.032 inch sheet.

   b. Finish: Smooth or Stucco. Reference Part 3 for jacket applications.

   c. Joining: Longitudinal slip joints and 2 inch laps.

   d. Fittings: 0.032 inch thick die shaped fitting covers with factory attached protective liner.

   e. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

   a. Water Vapor Transmission: 0.0 perms per ASTM E96.

   b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.

4. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

H. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.

I. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.

2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38, Design Polymerics 3040, or equal.

3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.

4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.

C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the

insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.3 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

3.4 PIPING SYSTEM INSULATION INSTALLATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Cold Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC Piping & Equipment” for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

F. Hot Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC Piping & Equipment” for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Secure all-service jacket with self-sealing longitudinal laps.

6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.

2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.

3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.

4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.

5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.

6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.

7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.

8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.

10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.

J. Exterior Piping and Piping Exposed to Weather:

1. General: Provide piping jacket around insulation as scheduled in the Piping Jacket Schedule. Jacket material shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of pipe. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.

2. Paintable Coating: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3. Polymeric Coating: Provide insulation shields so that the piping supports do not puncture, cut or break the jacket.

4. Rigid aluminum shell: Space attachment bands 12 inches on center and directly centered over end joints.

5. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.

6. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.

3.5 PIPE INSULATION THICKNESS SCHEDULE

A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.

b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where

1) T = minimum insulation thickness (in.),

2) r = actual outside radius of pipe (in.),

3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,

4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature ($Btu \cdot in/hr \cdot ft^2 \cdot °F$); and

5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.

d. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."

e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.6 PIPING JACKET SCHEDULE

A. Exterior piping, piping exposed to weather and piping in unconditioned spaces:

1. Paintable coating (flexible elastomeric insulation only.)
2. Polymeric Coating (flexible elastomeric insulation only).
3. Semi-rigid PVC for outdoor application(flexible elastomeric insulation on refrigerant piping only).
4. Rigid aluminum shell.
5. Multilayer laminate vapor barrier cladding.
6. Rubberized asphalt vapor barrier cladding.

3.7 DUCTWORK INSULATION SYSTEM INSTALLATION

A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces.

D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.

F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.

I. Cold Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
3. Seal joints with vapor barrier mastic.
4. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
6. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:
    a. Install thermal break such as rigid board insulation between the support and duct.
    b. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12 inches from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.
    c. If a support device similar to Unistrut is used, foam fill or stuff tube.

J. Hot and Neutral Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
3. Secure joints with staples, tape, or wires.
4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

3.8 DUCTWORK SYSTEM INSULATION SCHEDULE

A. Omit insulation on the following:

1. Fibrous glass ductwork (ductboard).
2. Lined ductwork that is interior to the building unless otherwise indicated on the drawings.
3. Interior ductwork with sound absorbing linings unless otherwise indicated on the drawings.
4. Exterior ductwork that is lined with duct liner or sound absorbing lining that has a minimum insulating value of R-8 unless otherwise indicated on the drawings.

B. Prohibited insulation:

1. Polyisocyanurate installed within a return air plenum.

C. Supply Air:

1. Service:
   a. Supply ducts from air handling equipment.
   b. Insulate neck and bells of supply diffusers.
2. Acceptable Insulation:
   a. Flexible mineral fiber.
   b. Rigid mineral fiber.
   c. Cellular glass.
   d. Polyisocyanurate.
   e. Flexible elastomeric.

D. Return Air:

1. Service:
   a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
   b. Interior ductwork routed through or from unconditioned spaces and plenums.
2. Acceptable Insulation:
   a. Flexible mineral fiber.
   b. Rigid mineral fiber.
   c. Cellular glass.
   d. Polyisocyanurate.
   e. Flexible elastomeric.

E. Exhaust Air.

1. Service:
   a. Interior ductwork within 10 feet of exterior roof or wall penetrations.

b. Interior ductwork routed through conditioned spaces (excludes ductwork routed in shafts) that is exhausting from unconditioned spaces (such as loading docks, garages, etc.).

2. Acceptable Insulation:

a. Flexible mineral fiber.

b. Rigid mineral fiber.

c. Cellular glass.

d. Polyisocyanurate.

e. Flexible elastomeric.

F. HVAC plenums and unit housings not pre-insulated at factory or lined.

1. Acceptable Insulation:

a. Flexible mineral fiber.

b. Rigid mineral fiber.

c. Cellular glass.

d. Polyisocyanurate.

e. Flexible elastomeric.

G. Exterior Ductwork:

1. Service:

a. Supply ductwork.

b. Return ductwork.

c. Exhaust ductwork.

d. Pre-conditioned outside air downstream of conditioning unit.

e. Plenums and unit housings not pre-insulated at factory or lined.

2. Acceptable Insulation:

a. Rigid mineral fiber.

b. Cellular glass.

c. Polyisocyanurate.

d. Flexible elastomeric.

e. Omit insulation on phenolic foam ductwork and fittings. Refer to Division 23 Section “Nonmetal Ducts.”

3.9 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

A. Flexible Mineral Fiber:

1. Interior Ductwork:

a. 0.75 pounds per cubic foot density:

1) 2 inch thick, minimum R-5.0.

b. 1.5 pounds per cubic foot density:

1) 2 inch thick, minimum R-6.0.

2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.

B. Rigid Mineral Fiber:

1. Interior Ductwork:

a. 1.5 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-6.0.

b. 3 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-6.0.

c. 6 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-6.0.

2. Ductwork installed in machine, fan, and mechanical equipment rooms:

a. 2 inch thick, minimum R-8.0.

3. Exterior Ductwork or Ductwork Exposed to Weather:

a. 2 inch thick, minimum R-8.0.

4. Ductwork in an Unconditioned Space:

a. 1-1/2 inch thick, minimum R-6.0.

C. Cellular Glass:

1. Interior Ductwork:

a. 1-1/2 inch thick, minimum R-5.0.

2. Exterior Ductwork or Ductwork Exposed to Weather:

a. 2-1/2 inch thick, minimum R-8.0.

3. Ductwork in an Unconditioned Space:

a. 2 inch thick, minimum R-6.0.

D. Polyisocyanurate:

1. Interior Ductwork:

a. 1 inch thick, minimum R-6.0.

2. Exterior Ductwork or Ductwork Exposed to Weather:

a. 1-1/2 inch thick, minimum R-8.0.

3. Ductwork in an Unconditioned Space:

a. 1 inch thick, minimum R-6.0.

E. Flexible Elastomeric:

1. Interior Ductwork:

a. 1-1/2 inch thick, minimum R-6.0.

2. Exterior Ductwork or Ductwork Exposed to Weather:

a. 2 inch thick, minimum R-8.0.

3. Ductwork in an Unconditioned Space:

a. 1-1/2 inch thick, minimum R-6.0.

3.10 DUCTWORK JACKET SCHEDULE

A. Omit jacket on internally lined ductwork.

B. Exposed ductwork:

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Aluminum with smooth finish.

C. Ductwork in an unconditioned space:

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).

END OF SECTION 230700

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Control panels.

B. Control valves.

C. Control dampers.

D. Operators.

E. Flow measuring apparatus.

F. Input/Output sensors and transmitters.

G. Output control devices.

H. Power Supplies.

I. Time clocks.

J. Weather stations.

1.2 DEFINITIONS

A. BAS: Building Automation System.

B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations.

C. Cv: Design Valve Flow Coefficient.

D. DDC: Direct Digital Control.

E. EPDM: Ethylene Propylene Diene Monomer.

F. High voltage: 50 volts or higher.

G. Low voltage: Below 50 volts.

H. PTFE: Polytetrafluoroethylene.

I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

J. Monitoring Meter: A water meter for determining water usage by a building system.

K. Sub meter: A water meter for determining water usage by a building tenant and used for billing purposes.

1.3 CONTRACTOR RESPONSIBILITIES

A. Reference Division 23 Section ”Coordination” for contractor responsibilities.

B. BAS Contractor:

1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.
2. Low voltage control wiring.
3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.
4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).
5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.
6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.
7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.
8. Perform startup and demonstration services as specified in Section “Direct Digital Control for HVAC”.

C. Sheet Metal Contractor:

1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
2. Access doors where and as required.

D. Mechanical Contractor:

1. Installation of immersion wells.
2. Installation of flow switches.
3. Installation of automatic control valves.
4. Installation of pressure tappings and associated shut-off cocks.
5. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.4 SUBMITTALS

A. Refer to Division 01 for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating

size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Schedule for control valves and actuators, including the following:

1. Tag.
2. Quantity.
3. Model number.
4. Equipment served.
5. Flow at project design conditions.
6. Selected valve flow coefficient (Cv). For butterfly valves, submit the corresponding valve position at which the Cv is calculated.
7. Pressure differential drop across valve at project design flow conditions and selected Cv.
8. Maximum close-off pressure.
9. Valve Configuration (2-way/3-way).
10. Valve Normal Position and Fail Position (e.g., NO/FO; normally open/fail open).
11. Valve Size.
12. Line Size.
13. Valve Type.
14. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)
15. Torque required to close valve at pump shutoff head.
16. Selected actuator maximum torque output.

E. Manufacturer's Instructions: Provide for all manufactured components.

F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

H. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.

D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.6 WARRANTY

A. Correct defective Work within a one year period after Substantial Completion.

B. Existing Equipment Warranty: Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, valves, actuators, devices, sensors, transmitters, and thermostats that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system startup and demonstration.

C. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.1 CONTROL PANELS

A. Construction:

1. Panel shall be UL 508A listed.
2. NEMA 250, general purpose utility enclosures with enameled finished face panel.
3. NEMA 4X utility enclosure for outdoor or wash-down applications.
4. Provide common keying for all panels.

B. Control panels serving packaged rooftop units shall be provided by the rooftop unit manufacturer. All other control panels shall be provided by the BAS contractor.

2.2 CONTROL DAMPERS

A. Dampers shall be factory fabricated and sized as shown on drawings and as specified. Dampers shall be provided by the sheet metal contractor.

B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.

C. Performance: Test in accordance with AMCA 500-D.

1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:
   a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.
      1) Maximum velocity of 1,500 feet per minute.
      2) Maximum Full-open air pressure drop of 0.1 inches W.C.
   b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.
2. Leakage:
   a. Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0

CFM/square foot in full closed position at 1inch W.G. pressure differential across damper.

b. Motorized dampers for other applications shall be Class II leakage.

D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.

1. Use minimum 16 gauge for rectangular dampers.
2. Use minimum 20 gauge for round dampers.
3. For aluminum frames, use 1/8 inch thick material.
4. All damper frames shall have a flange for duct mounting.
5. Reference Part 3 Execution for application of the material type.

E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.

1. Use minimum 16 gauge for rectangular dampers.
2. Use minimum 16 gauge for round dampers.
3. For aluminum blades, use 1/8 inch thick material.
4. The blades shall be suitable for the air velocities to be encountered in the system.
5. Dampers longer than the maximum blade length shall be fabricated in sections.
6. Reference Part 3 Execution for application of the material type.

F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.

1. Installed along the top and bottom of the frame and on all mating surfaces.

G. Jamb Seals: Spring stainless steel.

1. Installed inside the frame sides.

H. Shaft Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze.
2. Graphite impregnated nylon sleeve with thrust washers at bearings.
3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
4. Molded synthetic bearings.

I. Linkage Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze
2. Graphite impregnated nylon.

J. Maximum Pressure Differential: 6 inches wg.

K. Temperature Limits: -40 to 200 degrees F.

L. Smoke Control Damper Accessories

1. Fire/Smoke Damper

    a. Fire Stat: Provide UL classified dual temperature device that allows the damper to be re-opened after initial closure from high heat. Fire stat shall lock the damper closed when duct temperature exceeds temperature of 250 F. Fire stat shall allow the damper to remain operable from the control panel for smoke management purposes while air temperature is below the elevated temperature range specified herein.

    b. Blade Position Indicator Switches: Provide two position indicator switches linked directly to the damper blade to enable remote indication of damper position.

    c. Factory Sleeve: Provide minimum 20 gauge thick sleeve of length as required for the installation.

M. Manufacturers:

1. Greenheck.
2. CESCO.
3. Pottorff.
4. Nailor.
5. Ruskin.

N. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.

2.3 OPERATORS

A. General:

1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.

    a. Reference Part 3 for Damper Operator Voltage Schedule.

2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.
3. Construction:

    a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

    b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.

    c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

4. Field Adjustment:

    a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

    b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.

6. Modulating Actuators:

    a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.

    b. Control Input Signal:

        1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

        2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.

        3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.

    c. Programmable Multi-Function:

        1) Control Input, Position Feedback, and Running Time: Factory or field programmable.

        2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

        3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

7. Position Feedback:

    a. Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

    b. Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

    c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.

8. Integral Overload Protection:

    a. Provide against overload throughout the entire operating range in both directions.

    b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

9. Attachment:

    a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.

    b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.

10. Temperature and Humidity:

    a. Temperature: Suitable for operating temperature range encountered by application.

    b. Humidity: Suitable for humidity range encountered by application, non-condensing.

11. Enclosure:

    a. Suitable for ambient conditions encountered by application.

    b. NEMA 4 for indoor wash-down or wet locations.

    c. NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.

    d. Provide actuator enclosure with heater and control where required by application.

12. Stroke Time:

    a. Coordinate with stroke time indicated on the control drawings.

    b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.

B. Damper Operators:

1. Controls contractor shall size damper operator.

2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

    a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

    b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.

3. Fail Positions:

    a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.

        1) Return air damper, normally open.

        2) Outside air damper, normally closed.

        3) Exhaust/Relief air damper, normally closed.

    b. Operator shall fail in place for all other applications not listed under spring return.

    c. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are an acceptable alternate to spring return.

C. Manufacturers:

1. Damper Operators:

    a. Schneider Electric (Invensys).

2. Valve Operators:

a. Schneider Electric (Invensys).

2.4 INPUT/OUTPUT SENSORS AND TRANSMITTERS

A. General:

1. Performance Requirements:

a. Device must be compatible with project DDC controllers.

b. Elements used shall be general-purpose type.

c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.

1) Transmitters and transducers shall have offset and span adjustments.

2) Shock and vibration shall not harm the transmitter or transducer.

3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.

d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.

2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.

3. Input Power: Low voltage, nominal 24 Vdc.

4. Refer to the packaged rooftop unit schedules and/or control drawings for devices to be provided by the packaged rooftop unit manufacturer. All other required input/output sensors and transmitters are to be provided by the BAS contractor.

B. Temperature Sensors:

1. General: Temperature sensing elements shall have characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.

2. Performance Requirements:

a. Thermistor:

1) Accuracy (All): Plus/minus 0.36 degrees F minimum.

2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degrees F minimum.

4) Heat Dissipation Constant: 2.7 mW per degree C.

5) Drift: 0.04 degree F after 10 years within temperature range.

b. RTD:

1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.

2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.

a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.

b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.

c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degree F.

4) Drift: 0.04 degrees F after 10 years within temperature range.

c. Sensing Range:

1) Provide limited range sensors if required to sense the range expected for a respective point.

d. Wire Resistance:

1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.

2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.

3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

4. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.

5. Room Temperature Sensors:

a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.

b. Provide the following features:

1) Non-adjustable, blank front panel.

2) Locking cover where noted on the drawings.

6. Temperature Averaging Elements:

a. Use on duct sensors for ductwork 10 sq ft or larger.

b. Use averaging elements where prone to stratification with sensor length range between 16-22 ft.

c. Provide for all mixed air and heating coil discharge sensors regardless of duct size.

7. Insertion Elements:

a. Use in ducts not affected by temperature stratification or smaller than 10 sq ft.

b. Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.

c. Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.

C. Humidity Sensors:

1. Elements: Accurate within 3 percent full range with linear output.

   a. Accuracy shall include temperature effects.

2. Resolution: Plus/minus 1 percent.

3. Drift: Less than 1 percent full scale per year.

4. Sensing Range: 0 to 100 percent relative humidity.

5. Room Sensors: Provide housing with integral sensor. Housing shall be plastic, NEMA 250, Type 1. Provide with insulated backing suitable for exterior wall mounting.

6. Duct Sensors: Insertion type probe with mounting plate. Housing shall be metal, NEMA 250, Type 1.

7. Outside Air Sensors: With element guard and mounting plate.

D. Pressure Transmitters:

1. Duct Static Pressure:

   a. Type: Unidirectional, fixed range.

   b. Performance Characteristics:

      1) Accuracy: Plus/minus one percent of full scale.

      2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.

      3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.

      4) Long Term Thermal Stability: Plus/minus one percent full scale per year.

   c. Construction:

      1) Insertion or traverse type sensor suitable for use in flat oval, rectangular, and round duct configurations.

      2) Insertion length selected as appropriate for duct size.

      3) Traverse sensors shall have at least one pickup point every 6 inches.

      4) Element: Variable capacitance sensing technology.

      5) Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.

2. Space Static Pressure:

   a. Type: Bi-directional, fixed range.

   b. Performance Characteristics:

      1) Accuracy: Plus/minus 0.5 percent of full scale.

2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.

3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.

4) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.

c. Construction:

1) Sensing Port Wall Mounting: Wall plate with integral sensor, sized to fit standard single gang electrical box. Back of sensor plate fitted with union fitting for tubing connection.

2) Sensing Port Ceiling Mounting: Round plate with union fitting for tubing connection.

3) Sensor Element: Variable capacitance sensor technology.

4) Sensor Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.

E. Equipment Operation Sensors:

1. Status Inputs for Airside Equipment:

a. Type: Fixed range differential pressure switch with adjustable setpoint.

b. Performance Characteristics:

1) Range: Not greater than two times the design fan static pressure.

c. Construction:

1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.

2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.

3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.

2. Status Inputs for Electric Motors:

a. Analog Current Transducer:

1) Type: Split core design, cable of being installed or removed without dismantling the primary bus cables.

2) Performance Characteristics:

a) Accuracy: Plus/minus 2 percent of selected range.

b) Range: Multi-range device, suitable for the amperage encountered with internal zero and span adjustment.

c) Analog output signal: Generate a proportional control signal relative to the amount of current through the primary bus cables.

3) Construction:

a) 24 V or Self-powered (passive).

b) Provide with integral command relay.

c) Device shall accept overcurrent up to twice its trip into range.

d) Enclosure: UL 94 approved thermoplastic, rated for V-0. No metal parts shall be exposed other than the terminals.

b. Binary Current Sensing Relay:

1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.

2) Self-powered (passive) with solid-state circuitry and a dry contact output.

3) Adjustable trip point.

4) Contact Type: Single-pole, double-throw (SPDT).

5) LED indicating the on or off status.

6) A conductor of the load shall be passed through the window of the device.

7) Device shall accept overcurrent up to twice its trip into range.

2.5 OUTPUT CONTROL DEVICES

A. Control Relays:

1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.

2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.

3. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator.

4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.

5. Electromechanical relays shall be UL listed, compact in size, provided with quick connect terminals and be impervious to shock and vibration.

B. Electronic relays shall be microcomputer-based with PI, time proportioning control capability, have average life greater than 500,000 cycles, have a built-in transformer and have LED status indication.Fan Speed Controllers:

1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.

2.6 POWER SUPPLIES

A. Reference Division 23 Section “Direct Digital Controls for HVAC” for DC power supply requirements.

B. Control power transformers shall meet NEMA/ANSI standards.

C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.

D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.

E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.

F. Performance Characteristics:

1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.

G. Provide a disconnect switch for each transformer.

2.7 TIME CLOCKS

A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged, nickel-cadmium battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

2.8 WEATHER STATIONS

A. Manufacturers:

1. Davis Instruments.
2. Intellisense System
3. Meter Environment
4. WeatherHawk

B. Description:

1. Weather station shall measure and record wind speed and direction, air temperature and relative humidity, barometric pressure, solar radiation, and rain.
2. Design weather station for applications with minimal visual impact, high reliability, and a long interval between routine servicing.
3. Weather station shall use solid-state sensors with no moving parts.
4. Weather station shall not be impaired by heavy snowfall or freezing conditions that produce rime ice. Provide a thermostatically controlled heater element in the sensor head that keeps the wind sensor elements and the precipitation sensor surface free of snow and ice to minus 62 deg F.
5. Weather station shall directly connect to host device, or wirelessly connect to a host device through a fully integrated, industrial-grade, 916-MHz spread spectrum radio-frequency communications technology.
6. RS-232 serial data I/O shall be located on the bottom of the weather station and used as a second serial communications port, for programming and testing the system, or for direct data downloads using a personal computer or personal digital assistant.

7. Weather station shall be provided with a mounting system supplied by weather station manufacturer that is suitable for the installation.

C. Sensor Technology:

1. Wind speed and direction shall use acoustic techniques. Sensor shall consist of three equally spaced ultrasonic transducers in a horizontal plane. Values of any two array paths shall enable computation of both wind speed and direction, and a signal processing technique shall enable the measurement to be calculated using the two array paths of the best quality.

2. Rain shall be measured using a stainless-steel piezometric impact surface that counts the raindrops and measures their acoustic signature, integrating that information to provide a near-real-time value for rainfall amount and rate.

3. Barometric pressure, relative humidity, air temperature, and solar radiation measurements shall be made by scientific grade sensors.

4. Air-temperature and relative-humidity sensors shall be combined in an integrated, user-replaceable unit that requires no calibration.

   a. Relative humidity sensor shall be a thin-polymer, capacitive sensor.

   b. Air-temperature sensor shall be a capacitive ceramic sensor.

5. Barometric pressure shall be measured with a capacitive silicon, temperature-corrected, strain gage.

6. Solar radiation shall be measured by a silicon pyranometer with a cut filter limiting the spectral exposure to the 300- to 1100-nm wavelength.

D. Performance: Sensors shall have similar performance criteria as specified herein.

1. Air Temperature:

   a. Range: Minus 40 to 140 deg F.

   b. Accuracy: Within 0.9 deg F.

   c. Resolution: 0.1 deg F.

2. Relative Humidity:

   a. Range: Zero to 100 percent.

   b. Accuracy: Within 3 percent over the range of zero to 90 percent and within 5 percent between 90 to 100 percent.

   c. Resolution: 0.1 percent.

3. Barometric Pressure:

   a. Range: 17.72- to 32.48-in. Hg.

   b. Accuracy: 0.015-in. Hg between 32 to 86 deg F.

   c. Resolution: 0.03-in. Hg between minus 40 to 140 deg F.

E. Output Signals:

1. RS-232 or RS-485 serial interface directly from weather station to host.

2. In applications that cannot accept a serial signal, provide a serial-to-analog converter.

3. Serial-to-Analog Converter:

a. Serial converter designed to add analog outputs for measuring instruments that have only serial output.

b. Configure to give analog outputs from all measuring sensors and calculated parameters.

c. Each converter shall have four analog outputs with a 4- to 20-mA signal.

d. Provide multiple converters for applications requiring more points.

e. Converter requires a 24-V dc power supply.

F. Communication Interface:

1. Weatherproof serial cables shall be used to connect the RS-232 I/O on the weather station. Cables shall use nickel-plated brass DB-9 connectors for corrosion resistance and include a Sanoprene jacket suitable for both high-ultraviolet and direct-burial environments.

2. An RF4xx spread spectrum radio-frequency transceiver shall be provided with every wireless weather station.

G. Unit shall be provided with a 120-V ac, 60-Hz power supply, a serial cable, and an antenna.

H. Software:

1. Data Transfer Protocols, Software, and Data Interface Hardware: Weather stations that communicate using a proprietary protocol shall be provided with a software development kit to enable a qualified software developer in development of software drivers for third-party devices or software.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 EXISTING EQUIPMENT

A. Wiring: The contractor may reuse any abandoned wires. The integrity of the wire and its proper applications to the installation are the responsibility of the contractor. The wire shall be properly identified and tested. Unused or redundant wiring that remains in place shall be identified as such.

B. Local Control Panels: The contractor may reuse any existing local control panels to locate new equipment. All redundant equipment within these panels shall be removed. Panel

face cover shall be patched to fill all holes caused by removal of unused equipment or replaced with new.

C. Repair: Unless otherwise directed, the contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, notify the engineer immediately.

D. Indicator Gauges: Where these devices remain and are not removed, recalibrate and ensure reasonable accuracy.

E. Unless otherwise noted, salvage, recondition, and reuse the following devices:

1. Room thermostats.
2. Electronic sensors and transmitters.
3. Controller and auxiliary electronic devices.
4. Damper actuators, linkages, and appurtenances.
5. Control valves.

F. Patch holes and finish to match existing walls.

3.3 INSTALLATION

A. Install control valves, flow meters, operators, power supplies, output control devices, input/output sensors and transmitters in accordance with manufacturer's installation instructions.

B. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

C. Coordinate with other contractors performing work to provide emergency power to all control devices required to operate on emergency power.

1. Coordinate emergency power to BAS network control panels.
2. Coordinate emergency power to firefighter smoke control panel.
3. Coordinate power wiring for smoke control equipment is installed in metallic conduit.

D. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
3. Install all equipment in readily accessible locations.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Install all products in accordance with manufacturer's instructions.

E. Sensors:

1. Mount sensors rigidly and adequately for the environment within which the sensor operates.

2. Provide thermistor type temperature sensors for temperature ranges between minus 30 degrees F to 230 degrees F. Provide RTD type temperature sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.

3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.

4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

5. Sensors used in mixing plenums and hot and cold decks shall be of averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

6. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.

7. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 feet downstream.

8. Install temperature, humidity, and smoke detectors for both supply air and return air applications a minimum of 10'-0" downstream or upstream of the air handling unit and prior to any branch duct takeoffs.

9. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

10. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.

11. Differential air static pressure.

    a. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.

    b. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor or the plenum.

    c. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building. Pipe the high-pressure port to a location suitable to sense common building pressure or as indicated on the drawings.

        1) Panel mount the transducer adjacent to its associated building automation system controller. Provide an independent manometer gauge next to transducer for calibration.

    d. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

e. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

f. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

12. Adjust flow switch to meet sensitivity required to ensure minimum flow through the equipment.

13. Verify location and mounting height of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Align with adjacent lighting switches and humidistats.

a. Install devices to meet ADA requirements unless otherwise noted on the plans.

14. Mount freeze protection thermostats using flanges and element holders.

a. Install thermostat completely across the surface the thermostat serves.

15. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

16. Provide separable sockets for liquids and flanges for air bulb elements.

17. Provide thermostats in aspirating boxes in areas where flush mounting is required.

18. Provide guards on thermostats in areas indicated on the drawings.

19. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

20. Install shutoff valves in the high and low pressure reference lines connecting to hydronic pressure sensors and switches. Install a shunt valve across the high and low reference pressure ports for servicing. Valves may be ordered as an integral option with the sensor.

F. Control Dampers:

1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.

2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

3. Clearance:

a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

4. Service Access:

a. Dampers and actuators shall be accessible for visual inspection and service.

b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories.".

5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.

6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

8. Provide isolation (two position) dampers of parallel blade construction.

9. Provide opposed blade damper configuration for all other applications.

10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

G. Operators:

1. Mount and link control damper actuators according to manufacturer's instructions.

a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.

b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

c. Provide all mounting hardware and linkages for actuator installation.

2. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.

3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.

H. Control Panels:

1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.

2. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.

I. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

J. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

3.4 CONNECTIONS

A. Coordinate interlock of shutoff valves, operators, output control devices, input/output sensors, leak detection systems and transmitters where indicated on the drawings with the building automation system. Wiring and interlock with the building automation system are specified in Division 23 Section “Direct-Digital Control for HVAC”.

3.5 MAINTENANCE

A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

D. Smoke control diagrams shall be posted and be kept on file within the Fire Command Center and maintenance room upon completion.

3.6 STARTUP AND DEMONSTRATION

A. Control Dampers and Valves:

1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.
5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

3.7 DAMPER SCHEDULE

SERVICE	RUSKIN MODEL	MATERIAL
Outside, Exhaust and Relief Air Control, Stairway and Shaft Vents	CD-50	Aluminum
Fire/Smoke Damper for Smoke Control	FSD-60	Galvanized Steel

3.8 DAMPER OPERATOR VOLTAGE SCHEDULE

SERVICE	VOLTAGE
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

1. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

END OF SECTION 230913

SECTION 230914 - REFRIGERANT MONITORING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Refrigerant Monitoring Systems.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for the refrigerant monitoring system furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions.

B. Shop Drawings: Submit shop drawings for the refrigerant monitoring system, containing the following information:

1. Schematic flow diagram of system showing control panel and sensing device(s).
2. Label each control device with setting or adjustable range of control.
3. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
4. Provide details of faces of control panels, including controls, instruments, and labeling.
5. Include description of sequence of operation.

C. Maintenance Data: Submit maintenance instructions and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 01.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of refrigerant monitoring equipment, of types and sizes required, whose products have been in satisfactory use for a minimum of three years. Manufacturer shall submit a list of 12 similar projects.

B. Codes and Standards:

1. ASHRAE Compliance: Comply with ASHRAE 15 Safety Standard for Refrigeration Systems.
2. NEMA Compliance: Comply with NEMA standards pertaining to enclosures for refrigerant control systems
3. NFPA Compliance: Comply with NFPA 70 "National Electric Code" where applicable for electric equipment, devices and wiring.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device

B. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment.

C. Store equipment and materials inside and protect from weather.

1.5 SPARE PARTS

A. Provide two sets of spare filters for each type of sensing device furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Critical Environment Technologies

B. Genesis International, Inc.

C. Honeywell Analytics.

D. Macurco Gas Detection.

E. MSA, Instruments Division.

F. O-I-Analytical Corporation.

G. Sentech Corporation.

H. Specified Controls.

I. Thermal Gas System.

J. ToxAlert.

K. Trane.

L. YEW, Yokagowa.

2.2 REFRIGERANT MONITORING SYSTEM

A. General: Provide complete refrigerant monitoring system as specified, consisting of control panel, sampling system, and sensing devices as required for a complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer.

B. System Requirements: Meet the following general requirements:

1. Detect presence of any HCFC or HFC refrigerant regardless of which chiller is furnished. Coordinate with the Contractor the specific requirements for this installation.

2. Indicate, alarm, shut down equipment and communicate with the temperature control system specified in Division 23 Section "Direct Digital Control for HVAC" through an RS-232 or RS-485 port.

3. Locate leak detection monitoring sensors for early warning indication to prevent a major loss of refrigerant without alarm, should a leak occur.

C. Control Panel and Equipment: Provide control panel with suitable brackets for wall mounting, for each refrigerant monitoring system. Install panel at location shown on the drawings.

1. Fabricate panels of galvanized steel, painted steel, or extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, NEMA 4 rated.

2. Analyzer: Employ infrared sensor technology to provide sensing down to one part per million (ppm). Analyzer shall be compound specific and calibrated for the refrigerant application. System shall be capable of switching to another refrigerant type by changing one part and recalibration.

3. Alarm Contacts: Provide three adjustable levels of alarm and indicator lights for alarm levels, malfunction, loss of low and zero cycle. Alarm relays shall be rated for 120 Vac at 5 amps.

4. LED Display: Provide local LED display for indication of ppm level.

5. Calibration: Provide auto zero calibration manually at the monitor, automatically at user selected intervals between 15 minutes and 24 hours, or remotely via a dry contact input. Automatically zero by drawing air from an uncontaminated air source. Include a built-in sampling pump.

6. Flow Loss: Continuously sample flow. Indicate a flow loss when flow drops below 500 ml/min.

7. Operating Conditions: Capable of operating in ambient conditions of 0 to 40 degrees C, 0 to 99 percent relative humidity, non-condensing. System shall be insensitive to vibration.

8. Remote Sample Location: Capable of sampling from locations up to 500 feet from control panel.

9. Capable of expanding to a minimum of four sampling points with sequential sampling and output signals to allow monitoring from multiple remote sampling locations.

D. Refrigerant Sensor and Tubing: Provide refrigerant sensor(s) for monitoring refrigerant leaks in the chiller system. Provide application specific refrigerant sensor and particulate filters. Provide refrigerant sensing tubing of 1/4 inch diameter nylon tubing rated for a working pressure of 425 psi and burst pressure of 1,700 psi. Provide tubing with compatible fittings. Tubing shall be Parker Series NR or approved equal.

1. Refrigerant to Be Monitored: R-454B.

2. Accuracy: Sensor shall have accuracy of ± 5 ppm over range of 0 to 100 ppm and ± 5 percent of reading between 100 to 1,000 ppm.

3. Repeatability: Plus or minus 1 percent of full scale.

4. Detection Level Set Points:

a. Detection Level 1: 100 ppm.

b. Detection Level 2: 500 ppm.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which refrigerant monitoring systems are to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF REFRIGERANT MONITORING SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions.

1. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.

2. Mount control panel at location indicated on the drawings at convenient height for user interface.

B. Control Wiring: Install control wiring including conduit in accordance with requirements specified in Division23 Section "Direct Digital Control for HVAC."

C. Refrigerant Sensor(s): Install refrigerant sensor(s) at locations indicated on the drawings at height as recommended by the refrigerant monitoring system manufacturer.

D. Sensor Tubing: Install sensor tubing in accordance with manufacturer's instructions parallel to building columns. Support tubing as required to prevent sagging.

3.3 ADJUSTING AND CLEANING

A. Start-Up: Start-up, test, and adjust refrigerant monitoring system in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint. Replace sensor filters, if contaminated during installation work.

C. Final Adjustment: After completion of installation, adjust refrigerant monitoring system to meet system requirements.

D. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of refrigerant monitoring system.

3.4 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 01 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 230923 - DIRECT-DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. System Description.

B. Operator Interface.

C. Controllers.

D. Electrical Control Power Wiring and Low Voltage Wiring.

E. Local Area Network.

F. System Software.

G. Controller Software.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Coordinate routing of DDC power wiring and conduits requiring a fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of DDC power wiring and conduits requiring a fire-resistive protective assembly include, but are not limited to:

1. Wiring for Emergency Power systems.
2. Smokeproof Enclosure Pressurization systems.
3. Smoke Control systems.
4. Smoke Removal systems.
5. Fire service and Occupant Evacuation Elevator systems.

1.3 DEFINITIONS

A. ASC: Application Specific Controller. Examples include controllers for specific applications (e.g., FCU, VAV box, etc.) that can be configured through any network services software.

B. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).

C. BAS: Building Automation System.

D. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.

E. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and

like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

F. DDC: Direct Digital Control.

G. EMT: Electrical Metallic Tubing

H. High voltage: 50 volts or higher.

I. IP: Internet Protocol.

J. LAN: Local Area Network.

K. VLAN: Virtual Local Area Network.

L. Low voltage: Below 50 volts.

M. NiCS: Niagara Compatibility Statement license.

N. OSI: Open System Interconnection

O. PC: Personal Computer.

P. PICS: Protocol Implementation Conformance Statement.

Q. Point: Point is a generic term used to describe a single item of information in a BAS. Points may be further described as input, output, digital, binary, discrete, analog, modulating, internal, external, virtual or global. Each unique point used by digital controllers, or in a BAS, is typically identified by an address.

1.4 CONTRACTOR RESPONSIBILITIES

A. Reference the following sections for additional contractor responsibilities and coordination:

1. Division 23 Section “Electrical Coordination for Mechanical Equipment.”
2. Division 23 Section “Commissioning for HVAC.”
3. Division 23 Section “Instrumentation and Control Devices for HVAC.”

B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.5 SUBMITTALS

A. Refer to Division 01 and Division 23 Section “General Mechanical Requirements” for submittal procedures.

B. General:

1. The drawings and specifications are not intended to show all details. The BAS contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation for the devices and system described.

2. Inform Engineer in writing of any deviation in the exhibits submitted from the requirements of the drawings, specifications, and sequences of operations.

C. Product Data:

1. Submit manufacturer technical data for each system component and software module required for a complete installation.

2. Indicate dimensions, weights, and enclosure construction for all BAS distributed controllers.

3. Submit technical data on all new software supplied including description of functions performed by software and location within the system where software shall reside. Include all software licensing agreements.

4. Submit the PICS for each BACnet device used in the BAS.

5. Submit the NiCS for each type of Niagara station in the BAS.

D. Power and Communication Wiring Transient Protection:

1. Submit catalog data sheets providing evidence that all BAS products offered by the manufacturer are tested and comply with IEEE C62.41.2.

2. Testing shall include power and communication trunk wiring.

3. Compliance with IEEE C62.41.2 shall imply conformance with IEEE C37.90.1based on the stated position of ANSI and IEEE.

E. Shop Drawings:

1. Submit a trunk cable schematic showing locations of all programmable control units, controllers, and workstations, with associated network wiring.

   a. Indicate equipment served by each controller on the diagram.

   b. Indicate switches, power requirements to each controller, and daisy chained controllers.

2. Submit detailed schematic control drawings for each controlled device and equipment.

   a. Reference all control components to manufacturer make and model number.

   b. Include all control and power wiring with termination point (controller and terminal number).

   c. Include clearly indicated and written sequences of operation referenced to specific control components (e.g., "shall modulate valve V-3").

   d. Include default position (e.g., N.O., N.C., etc.) for all components where applicable.

   e. Clearly differentiate between existing components and new components.

   f. Include detailed wiring diagrams showing methods of connections to VFDs, motor starters, energy meters, and all other devices, and all other field wiring necessary for system installation.

   g. The use of ”typicals” will be allowed where appropriate.

3. Submit detailed drawings for each individual BAS distributed controller.

   a. Include controller identification.

b. Include components included in the controller.

c. Include numbering of terminals and communications ports.

d. List connected data points, including connected control unit and input device.

e. Include type of cable connected to each terminal port.

f. Identify specific field devices wired to each terminal including identification of each field device and application.

g. Clearly differentiate between existing controllers and new controllers.

h. Indicate source (electrical panel ID) of 120V power to each panel to which 120V power is connected.

i. Indicate method of connecting controller to equipment supplied by others and to existing communications networks.

j. Indicate device instance and network number.

4. Submit floor plans that indicate the following:

a. Location of all new BAS distributed controllers and control panels.

b. Routing of all new building level network communications wiring not located in mechanical and electrical rooms.

c. Routing of wiring to controllers, sensors, and control points not located in mechanical and electrical rooms.

d. Location of building system connection to Owner's campus wide data network.

5. Submit methods and materials used to integrate into existing networks.

6. All control drawings and schematics shall be generated using AutoCAD software or equivalent. All project drawings shall be supplied to the Owner in a format as desired by the Owner upon project completion.

1. Submit system identification nomenclature.

a. Nomenclature shall be consistent throughout the network and consistent with any existing networks that are integrated. If not defined, nomenclature shall be similar to the point names shown on the drawings.

b. Object name and ID number shall be unique within a control device.

c. Control device instance name and ID number shall be unique within the network.

d. Network number shall be unique for each unique electrical segment in the BAS.

7. Indicate system graphics indicating monitored systems, data (connected and calculated) and operator notations.

a. Submit example graphic visualizations and screenshots for the BAS. At a minimum, submit examples for major HVAC equipment components, including chillers, boilers, air handling units, fan coil units, heat pumps, fans, etc.

b. Font size and type shall be manufacturer standard.

c. Provide graphics demonstration package in a format as desired by the Owner.

8. Indicate description and sequence of operation of operating, user, and application software.

F. Controller Manual Download Schedule:

1. Submit a schedule of controllers which cannot automatically download changes to its application program (e.g., schedules, setpoints, etc.) from the integrated BAS and require manual download of changes via local connection of service laptop by maintenance staff. Include the following information in the schedule:

a. Building name.

b. Room name of controller location.

c. Equipment served by controller.

G. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

H. Manufacturer’s qualification statement.

I. Installer’s qualification statement. Installer shall be C&C Group.

J. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittals data in final "Record Documents" form.

3. All additions or changes to the BAS during the course of construction shall be reflected upon the drawings and submitted to the Engineer before project close-out.

K. Testing and Commissioning Reports and Checklists: Submit completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Startup and Demonstration.

L. Operation and Maintenance Data:

1. Include maintenance data and recommended spare parts list for digital control equipment and control components.

2. Include trouble-shooting maintenance guides.

3. Include interconnection wiring diagrams showing complete field installed systems with identified and numbered system components and devices.

4. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

5. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

6. Include a maintenance manual which contains the information listed above, product data, shop drawings, final software code for sequences of operation and maintenance data in accordance with requirements of Division 01.

7. Include logbook for documentation of software updates and patches applied BAS for the time period included in the software licensing agreement.

8. Provide names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

M. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

N. Maintenance Materials:

1. Refer to Division 01 for additional provisions.

2. Extra Stock Materials: Two printer cartridges and cartons of printer paper.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. BACnet devices used in the BAS shall be BTL listed according to its device profile.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Installer Qualifications: Company specializing in performing the work of the type specified and with minimum documented experience as follows:

1. All personnel of the BAS Contractor shall have a minimum of three years of experience within their appropriate trades.

2. All subcontractors utilized by the BAS Contractor shall have a minimum of five years experience within their appropriate trades.

F. Additional BAS Contractor Requirements:

1. Personnel, Coverage and Response Capabilities: The BAS Contractor shall have a fully staffed office with service technicians and systems engineers within a 50 mile radius of the project location.

2. Emergency Service: The BAS Contractor shall have an established 24 hour emergency service organization. A dedicated telephone number shall be provided to the Owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BAS Contractor.

3. Parts Stocking: The BAS Contractor shall have an independently verifiable inventory of electronic service parts. This electronic service parts inventory must have a worth of at least $100,000 per year over the last five years.

4. Past Projects: The BAS Contractor shall have completed a minimum of twenty projects within the last five years which are at least equal in dollar value and comparable scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS Contractor if asked for by the Owner.

1.7 WARRANTY

A. Refer to Division 01 for additional project warranty requirements.

B. Labor and materials for the BAS specified shall be warranted free from defects in workmanship and material for a period of 1 year after Substantial Completion and system acceptance.

C. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

D. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start data and period.

E. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

F. Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, wiring, and controllers that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system commissioning.

G. Provide five year manufacturer's warranty for field programmable micro-processor based units.

H. Special warranty on instrumentation:

1. All instrumentation shall be covered by manufacturer's transferable one-year "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.8 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

B. Software provider shall provide software updates and patches to the BAS as part of the software licensing agreement as the updates and patches are released. If any security vulnerabilities are discovered by the provider, the provider shall notify the client within five business days.

C. Ownership of Proprietary Material: Project-specific software and documentation shall become Owner's property upon project completion. This includes, but is not limited to the following:

1. Graphics.
2. Record drawings.
3. Database.
4. Application programming code.
5. Documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Corporate Edition Products: The following manufacturers and product lines shall be manufacturer's most current vintage and of open protocol design. Corporate editions shall be based on manufacturer developed software.

1. Schneider Electric by C&C Group, contact Corey Schepers 913-530-7369 or cschepers@c-cgroup.com.

B. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, building controllers, custom application controllers, and application specific controllers. All other products specified under Division 23 Section "Instrumentation and Control Devices for HVAC" need not be manufactured by the above manufacturers.

2.2 SYSTEM DESCRIPTION

A. General:

1. The BAS shall consist of all necessary hardware and software to perform the control sequences of operation as called for in the Specifications and Drawings. Contractor shall install and commission all necessary devices to ensure a reliable and stable network.
2. System design is based on a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
3. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
4. The BAS shall be capable of integrating multiple devices, sensors, and functions from multiple control vendors into a common front end, including equipment supervision and control, alarm management, energy management, and trend data collection.
5. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.
6. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

B. Local Area Network:

1. The BAS shall be set up as a physically separate network within the building.

2. The BAS shall be set up using a VLAN connection into the Owner's internet or enterprise intranet. The VLAN shall be digitally separate from all other networks and shall share a common physical cabling backbone. Coordinate with the Owner to configure Ethernet and IP router switches to accommodate the VLAN.

C. Network Architecture: The BAS network architecture shall be based upon the OSI basic reference model in accordance with ISO 7498.

1. Application/Network Layer:

a. BACnet protocol complying with ASHRAE Standard 135.

2. Physical/Data Link Layer:

a. Hard-wired type:

1) Ethernet according to ISO 8802-2 protocol.

2) EIA-485 Twisted Cable Pair according to Master Slave/Token-Passing (MS/TP) protocol.

3) Applicable media for use with LonTalk protocol.

3. Communication between operator workstation(s) and building controller(s):

a. Ethernet.

b. MS/TP.

4. Communication between building controller(s) and application specific and custom application controllers:

a. MS/TP.

b. PTP.

D. Web Services Enabled Network:

1. The network shall be capable of being accessed remotely over the internet via a virtual link according to Internet Protocol.

2. System software shall be based on a client/server architecture, designed around the open standards of web technology. The BAS server shall be accessed using a web browser over the BAS network, Owner's LAN, and remotely over the Internet (through the Owner's LAN).

3. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming. Connection shall be browser agnostic.

4. Software applications shall be designed and optimized for hand-held device interface (e.g., tablets, smart phones, etc.). Interface shall grant visibility and control access, at a minimum, to the following data: Summary, Alarm, Setpoints, Status, Schedule, and Trending.

E. Network Integration:

1. The BAS network shall be integrated with other automation networks controlled by the Owner. Coordinate with the Owner's information technology (IT) department for networks that shall be integrated.

2. Provide gateways or other integration devices across networks with different communication protocol to provide a single network visibility and interoperability at the operator workstation. Coordinate communication protocol with each automation system specified.

3. Interoperable networks shall be capable of sharing all point and point information across networks to a single BAS front end.

4. Interoperable networks shall be capable of automatically downloading application program changes.

5. For integrated networks that cannot automatically download application program changes, provide a link to the Controller Manual Download Schedule, as defined in the submittals section of Part 1 on the BAS front end summary page

6. Integrate the following networks:

a. Fire alarm control panels.

F. Network Interoperability:

1. Provide communication between control units over local area network (LAN).

2. Communication services over the LAN shall result in operator interface and value passing that is transparent to the network architecture as follows:

a. Connection of an operator interface device to any one controller on the network shall allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.

b. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the network. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform network value passing.

2.3 OPERATOR INTERFACE

A. General:

1. The Operator Interface shall provide overall BAS supervision and system software interface. Communications from the workstation shall be executed directly to and between the integration level building controllers and field level controllers.

2. The operator interface shall be capable of command entry, information and alarm management, database management, access of all system data, and be independent of hardware technology.

B. Hardware:

1. Desktop:

a. Computer(s) and display(s) to be provided by BAS controls manufacturer.

b. PC shall be general purpose and commercially available, with sufficient memory and processing capability to meet the requirements of the BAS.

1) Quantity: 1.

2) Minimum RAM: 8.0 gigabytes.

3) Minimum Processing Speed: Intel i3 Dual Core Microprocessor or better running at no less than 3.0 gigahertz.

4) Minimum Hard Drive Memory: 500 gigabytes.

5) Ports:

a) Minimum of 2 USB 2.0 or faster ports on front of tower.

b) Minimum of 2 free USB 2.0 or faster ports on rear of tower.

c. Monitor: Minimum 17 inch VGA or higher resolution, color graphic LCD or LED monitor with a compatible VGA or higher resolution card.

d. Location(s): As directed by the Owner.

e. Network Connection:

1) Suitable for network technology provided.

2) Ethernet interface card with minimum Speed: 10/100/1000.

f. Standard 101 key keyboard.

g. Standard mouse with track wheel.

2. Database Save/Restore/Back-Up:

a. Back-up copies of all Building Controller and ASC data as well as mass storage for trend logs shall be stored in the mass storage device designated by the Owner.

2.4 CONTROLLERS

A. Building Controllers

1. General:

a. Input Power Requirements: 24Vac.

b. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.

c. Provide sufficient memory to support controller's operating system, database, and programming requirements.

d. Share data between networked controllers.

e. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allow for central monitoring and alarms.

f. Utilize real-time clock for scheduling.

g. Continuously check processor status and memory circuits for abnormal operation.

h. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

i. Communication with other network devices to be based on assigned protocol.

j. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

a. Perform routing when connected to a network of custom application and application specific controllers.

b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

1) Port shall be USB type.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:

a. Use for interrogating and editing data.

b. System security password prevents unauthorized use.

c. If the manufacturer does not normally provide a keypad and display for the controller, provide software and interface cabling needed to use a portable operator terminal for the system.

5. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

7. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.

b. Perform orderly shutdown below 80 percent of nominal voltage.

c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.

d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

8. Surge and Transient Protection:

a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

B. Application Specific Controllers

1. General:

a. Input Power Requirements: 24Vac.

b. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.

c. Customized for operation within the confines of equipment served.

d. Provide sufficient memory to support controller's operating system, database, and programming requirements.

e. Communication with other network devices to be based on assigned protocol.

1) Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

f. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

2. Communication:

a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F and 95 percent RH, non-condensing.

4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory. In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:

   a. Maintain operation at 90 to 110 percent of nominal voltage rating.

   b. Perform orderly shutdown below 80 percent of nominal voltage.

   c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.

   d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

7. Surge and Transient Protection:

   a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

   b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

C. Input/Output Interface

1. Hardwired inputs and outputs shall tie into the BAS through building, custom application, or application specific controllers.

2. All Input/Output Points:

   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.

   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

   c. Universal-type inputs or outputs configurable between binary and analog are acceptable.

3. Binary Inputs:

   a. Allow monitoring of On/Off signals from remote devices.

   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.

   c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.

5. Analog Inputs:

   a. Allow for monitoring of low voltage 0 to 10 Vdc, 4 to 20 mA current, or resistance signals (thermistor, RTD).

   b. Compatible with and field configurable to commonly available sensing devices.

6. Binary Outputs:

   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.

   b. Outputs provided with three position (On/Off/Auto) override switches.

c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:

a. Monitoring signal provides a 0 to 10 Vdc or a 4 to 20 mA output signal for end device control.

b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.

c. Drift to not exceed 0.4 percent of range per year.

8. Tri State Outputs:

a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.

b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:

1) VAV terminal units.

2) Duct mounted heating coils.

3) Zone dampers.

4) Radiant devices.

c. Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.5 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Power Wiring: Copper wiring, plenum cable, and raceways shall be as specified in the applicable section of Division 26.

B. Power and Communication Wiring Transient Protection:

1. Comply with IEEE C62.41.2.

2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.

3. Communication circuitry, input/output circuitry, and communication unit shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations.

a. For systems not complying with this requirement, provide equivalent protection external to the automatic temperature control system controller. Protection shall be provided for the individual communications and input/output terminations for each automatic temperature control system controller.

b. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

C. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Supplies shall be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

D. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
    a. Dielectric strength of 1000 volts minimum.
    b. Response time of 10 nanoseconds or less.
    c. Transverse mode noise attenuation of 65 dB or greater.
    d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

E. Input/Output Control Wiring

1. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.
2. In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.
3. Control wiring not installed in conduit shall be UL rated for plenum installation.
4. Ethernet control wiring shall be fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
5. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.
6. Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.
7. Binary control function wiring shall be a minimum of number 18 gauge.
8. Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.
9. Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.

10. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.

11. 120V control wiring shall be #14 THHN in 3/4 inch conduit. Provide 20% fill extra wire in each conduit.

F. Splices: Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding.

G. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: EMT with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

H. Relays

1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2. Solid State Relays (SSR):

a. Input/output isolation: Greater than 10 E^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz.

b. Contact Life: 10 x 10 E^6 operations or greater.

c. Ambient Temperature Range: Minus 20 to +140 degrees F.

d. Input impedance: Not be less than 500 ohms.

e. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

3. Contactors:

a. Type: Single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts.

b. Positive locking shall be obtained without the use of hooks, latches, or semi permanent magnets.

c. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

2.6 SYSTEM SOFTWARE

A. General:

1. Provide all necessary system software to form a complete operating system for all operator interface devices.

2. System software shall integrate with all controller software and allow management of software applications at the operator workstation.

3. System software display language: English.

B. Device Profile: BACnet devices shall Conform to the following device profiles as specified in ASHRAE/ANSI 135 BACnet Annex L:

1. Operator workstation: [BACnet Operator Workstation (B-OWS)][BACnet Advanced Workstation (B-AWS)].

2. Building Controller: BACnet Building Controller (B-C).

3. Advanced Application Controller: BACnet Advanced Application Controller (B-AAC).

4. Application Specific Controller: BACnet Application Specific Controller (B-ASC).

C. Software Programming:

1. Provide programming for the system and adhere to the sequences of operation provided. Provide actions for all possible situations. All other system programming necessary for the operation of the system shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Provide text-based, graphic-based, and parameter-based programming where appropriate.

D. Operating System:

1. Concurrent, multi-tasking capability.

2. Common Software Applications Supported:

a. Microsoft Windows and Microsoft Office Suite.

b. Open platform compatible database: Microsoft Access, Oracle Database, IBM Analytics, or other SQL database software. Proprietary databases shall not be acceptable.

3. Acceptable Operating Systems: Most recent version of operating system.

E. System Graphics:

1. Color type, saved in an industry-standard format such as BMP, JPEG, PNG, or GIF.

2. Allow simultaneous display for comparison and monitoring of system status.

3. Web based graphics shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X, Java Virtual Machine, and Adobe Flash).

4. Animate displayed objects by shifting image files of objects based on object status.

5. Functionality: Provide method for operator with password to perform the following:

a. Move between, change size, and change location of graphic displays.

b. Modify on-line.

c. View a summary of the most important data for each controlled zone or piece of equipment.

d. View a summary of the most important global data for the project, including but not limited to date, day of week, time, outdoor dry bulb temperature, and humidity.

e. Use point-and-click navigation between graphic screens.

f. Edit setpoints and other specified parameters.

a. Edit equipment names and numbers.

b. Edit room names and numbers.

g. Indicate areas or equipment in an alarm condition using color or other visual indicator.

h. Add, delete, or change dynamic objects consisting of:

1) Analog and binary values.

2) Dynamic text.

3) Static text.

4) Animation files.

i. Display graphic file, text, and dynamic object data together on a single graphic. Display all measured and commanded data, setpoints, calculated values, and input and output control points with appropriate engineering units associated with each system schematic.

j. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

k. Dynamic Data Displays shall be capable of including point data from multiple ASC's.

6. Include at least one graphic for each of the following:

a. Each piece of equipment.

b. Occupied zone.

c. Hydronic system (chilled water, condenser water, hot water, steam, heat pump, etc.)

d. Floor plan displays of the building. Indicate summary conditions for each floor.

e. Indicate thermal comfort on floor plan using dynamic colors to represent zone temperature relative to zone setpoint.

7. Graphic Tree Structure:

a. Structure graphic system tree to allow access to individual graphic screens from a macro to a micro level.

b. Allow each level of graphic direct access to the graphic screen above and below the graphic screen in the system tree.

c. Allow direct access to the main summary graphic screen/map from any individual graphic screen.

8. Sequence of Operation Graphics:

a. Display the complete Sequence of Operation or include a link to a separate text file that contains the sequence of operation, as submitted by the Contractor and approved by the Engineer with each system schematic view. The Sequence of Operation text shall be in a separate frame above, below, or to the side of the graphic as appropriate for the graphic size and content.

9. Custom Graphics Generation Package:

a. Allow operator to create, delete, modify, and save custom graphic files and displays. File format of graphics shall be compatible with BAS software.

b. Web-based Graphics: HTML graphics to support web browser compatible formats.

c. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard components with which custom graphics may be built. Standard components include but are not limited to

1) Air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.).

2) Complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.).

3) Hydronic system components (e.g., chillers, boilers, pumps, piping, valves, etc.).

4) Electrical symbols.

d. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following

1) Define symbols.

2) Position and size symbols.

3) Define background screens.

4) Define connecting lines and curves.

5) Locate, orient and size descriptive text.

6) Define and display colors for all elements.

7) Establish correlation between symbols or text and associated system points or other displays.

8) Capture or convert graphics from AutoCAD.

e. Graphical displays shall be capable of representing a group of objects. Groups shall be capable of representing any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the building.

2. Standard HVAC Graphics Library: Furnish a complete library of standard HVAC equipment graphics and standard symbols for ancillary equipment in a file format

compatible with the graphics generation package program. Graphics shall include, but not be limited to, the following:

a. HVAC Equipment:

1) Chillers.

2) Boilers.

3) Air Handlers.

4) Terminal HVAC Units.

5) Fan Coil Units.

6) Unit Ventilators.

7) Heat Exchangers.

b. Ancillary Equipment:

1) Fans.

2) Pumps.

3) Coils.

4) Valves.

5) Piping.

6) Dampers.

7) Ductwork.

F. Workstation System Applications:

1. General Application Functions:

a. All applications shall be capable of being executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization.

b. Allow BAS configuration and future changes or additions by operators with password protection.

c. Execute configured processes defined by the user to automatically perform calculations and control routines.

d. Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

1) Any system-measured point data or status

2) Any calculated data

3) Any results from other processes

4) Boolean logic operators (and, or)

e. Process Triggers: Configured processes may be triggered based on any combination of the following:

1) Time of day

2) Calendar Date

3) Other processes

4) Events (e.g., point alarms)

f. Data Access: A single process shall be able to incorporate measured or calculated data from any and all other ASC's. In addition, a single process shall be able to issue commands to points in any and all other ASC's on the local network.

2. Network Configuration:

a. Allow for configuration of the BAS network.

b. Provide alarm when a break in communication between devices is detected.

c. Enable the operator to add, delete, or modify the following:

1) Building controllers and ASC's.

2) Points of any type, point parameters, and tuning constants.

d. Provide automatic reconfiguration if any station is added or lost.

3. Save and Restore:

a. Automatic System Database Save and Restore Functions:

1) Store current database copy of each Building Controller on hard disk or server.

2) Backup database on a user adjustable frequency basis. Default frequency shall be monthly.

3) Automatically update upon change in any system panel.

4) In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

b. Manual System Database Save and Restore Functions by Operator with Password Clearance:

1) Save database from any system panel.

2) Clear a panel database.

3) Initiate a download of a specified database to any system panel.

4. On-line Help:

a. Include context-sensitive system to assist operator in operation and editing.

b. Include topics available for all applications.

c. Include relevant screen data provided for particular screen display.

d. Include additional help via hypertext.

5. Security:

a. Require user name and password for Operator log-on to view, edit, add, or delete data.

b. Include selectable system security for each operator. Support a minimum of five levels of access:

1) Level 1 = Read-only data access and display.

2) Level 2 = Level 1 + scheduling.

3) Level 3 = Level 2 + operator overrides and commands.

4) Level 4 = Level 3 + database generation and modification.

5) Level 5 = Level 4 + Audit trail management.

6) Operators shall be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined as accessible for the user.

7) Support a minimum of 4 passwords at each Building Controller.

c. Allow system supervisor to set passwords and security levels for all other operators.

d. Allow operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.

e. Include automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.

f. Store all system security data in encrypted format.

g. Log all user actions and store data for audit with permission access by system administrator only.

1) Include the modified system.

2) Include the value modified.

3) Include the time of modification.

6. System Diagnostics:

a. Operations Automatically Monitored:

1) Workstations.

2) Printers.

3) Network connections.

4) Building management panels.

5) Controllers.

b. Device failure is annunciated to the operator.

7. Alarm Management:

a. Allow alarm prioritizing to minimize nuisance reporting and to speed operator response to critical alarms.

1) Provide a minimum of three, user definable priority levels.

2) Enable users to manually inhibit alarm reporting for each point.

3) Enable users to manually inhibit nuisance alarm reporting for maintenance or repair work that is scheduled to be performed.

4) Enable user to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

5) Allow alarm prioritization to lock out or circumvent other alarms that may be generated as a result of primary alarm.

b. Prohibit interference with the ability of the system software to report alarms by either operator activity at the local I/O device, or communications with other system controllers on the network.

c. Allow all system objects that are configurable to "alarm in" and "alarm out" of normal state.

d. Configurable Objects:

1) Alarm limits.

2) Alarm limit differentials.

3) States.

4) Reactions for each object.

5) Alarm delay.

e. Alarm Messages:

1) Descriptor: English language. Acronyms or mnemonics for objects in alarm are not acceptable.

2) Recognizable Features:

a) Source.

b) Location.

c) Nature.

d) Time and Date.

e) Alarm message box to more fully describe the alarm condition or direct operator response.

f) Each Alarm messages shall be assignable to any point in the BAS. Alarm messages shall be assignable to multiple points.

g) Notification of an alarm override.

f. Configurable Alarm Reactions by Workstation and Time of Day:

1) Logging.

2) Printing.

3) Starting programs.

4) Displaying messages.

5) Phone text message.

6) Email.

7) Providing audible annunciation.

8) Displaying specific system graphics.

8. Custom Trend Logs:

a. Maintain trend information for minimum 365 days.

b. Definable for any data object in the system including interval, start time, and stop time.

1) Resolution: Interval periods shall be adjustable down to one minute.

2) Multiple Interval Period: Each trended point shall have the ability to be trended at a different trend interval.

c. Trend Data:

1) Sampled and stored on the building controller panel.

2) Auto-Delete Period: Software shall be capable of automatically deleting stored trend data after a user-adjustable period of time. Each trended point shall have the ability to have a different auto-delete interval period.

3) Archivable on hard disk or server.

4) Retrievable for use in reports, spreadsheets and standard database programs.

5) Protected and encrypted format to prevent manipulation or editing of historical data and event logs.

d. Trend Graph Display:

1) Group Trend Time Series Plots:

a) Provide user-selectable Y-axis points.

b) Provide user editable titles, point names, and Y-axis titles.

c) Individual trended points shall be able to be grouped into groups of up to four points per plot with up to four plots per page.

2) X-Y Trend Plots:

a) User selectable X and Y trend inputs.

b) User editable titles, point names, and X and Y-axis titles.

c) User selectable time period options:

i) 1-day 24-hour period.

ii) 1-week 7-day period.

iii) 1-month period with appropriate days for the month selected.

iv) 1-year period.

v) User shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.

vi) User selectable display up to 6 plots per screen in 2 columns.

3) Automatic Scaling: System shall automatically scale the axis on which trends are displayed when multiple points with different trend interval periods are selected for graphical display.

4) Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.

5) Zoom: Software shall allow zoom-in function for detailed examination of trends.

e. Numeric Value Display: Software shall display value of any sample on a trend when picked.

9. Alarm and Event Log:

a. View all system alarms and change of states from any system location.

b. List events chronologically.

c. List alarm priority.

c. Allow operator with proper security to acknowledge and clear alarms. Log operator and time when alarm is acknowledged.

d. Archive alarms not cleared by operator to the workstation.

10. Object, Property Status, and Control:

a. Provide a method to view, edit if applicable, the status of any object and property in the system.

b. Status Available by the Following Methods:

1) Menu.

2) Graphics.

3) Custom Programs.

11. Clock Synchronization:

a. The real-time clocks in all building control panels and workstations shall be able to automatically synchronize daily from any operator-designated device in the system.

b. The system shall automatically adjust for daylight savings and standard time, if applicable.

12. Reports and Logs:

a. Reporting Package:

1) Allow operator to select, modify, or create reports.

2) Definable as to data content, format, interval, and date.

3) Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

4) Provide ability to obtain real-time logs of all objects available by type or status such as alarm, lockout, normal, etc.

5) Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.

6) Allow printing on operator command or specific time(s).

b. Standard Report Format Options:

1) Objects with current values.

2) Global modification values.

3) Current alarms not locked out.

4) Disabled and overridden objects, points and variables.

5) Objects in manual or automatic alarm lockout.

6) Objects in alarm lockout currently in alarm.

7) Objects currently in override status.

8) Objects in Schedules

a) Daily.

b) Weekly.

c) Holiday.

9) Logs:

a) Alarm History.

b) System messages.

c) System events.

d) Trends.

c. Custom Report Format Options:

1) Daily.

2) Weekly.

3) Monthly.

4) Annual.

5) Time and date stamped.

6) Title.

7) Facility name.

8) Point Groups.

a) User-selectable.

b) Group may be comprised of specific points, group of equipment objects, group of groups, or for the entire facility without restriction due to the hardware configuration of the BAS.

d. Electrical, Fuel, and Weather:

1) Electrical Meter(s):

a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.

b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

2) Fuel Meter(s):

a) Monthly showing daily fuel consumption for each meter.

b) Annual summary showing monthly consumption for each meter.

3) Weather:

a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

13. Global Modify:

a. Allow global modification of all editable data. Similar data shall be grouped into logical objects based on building function, mechanical system, building layout, or any other logical grouping of points.

b. Allow each common type of equipment to be excluded or included within the global editing process.

c. Display status information on all similar points in one global report.

d. Allow modification of the following:

1) Individual data point edited.

2) List of all points within the category.

3) Global change field.

4) Copy feature to assist in downloading the new changes.

5) Verification that all changes were completed.

e. Include a change-all feature to change all selections.

f. Prevent acceptance of changes until an accept icon is acknowledged.

G. Workstation Applications Editors:

1. Provide editing software for each system application at the PC workstation.

2. Edited applications shall be automatically downloaded and executed at the controller panel.

3. Programming Description: Definition of operator device characteristics, ASC's, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.

4. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.

5. System definition and modification procedures shall not interfere with normal system operation and control.

6. Provide consistent text-based displays of all system point and system applications.

7. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

8. Full screen editor for each application shall allow operator to view and change:

a. Configuration.

b. Name.

c. Control parameters.

d. Set-points.

e. Schedules.

9. Scheduling:

d. Allow scheduling down to the zone or room level.

a. Monthly calendar indicates schedules, holidays, and exceptions.

b. Allows several related objects to be grouped, scheduled, and copied to other objects or dates.

c. Start and stop times adjustable from master schedule.

e. Schedule expiration.

d. Temporary overrides of systems with user adjustable time-out.

f. Provide minimum three tiers of priorities for scheduling.

1) Priority 1: Event, temporary, or override.

2) Priority 2: Calendar.

3) Priority 3: Default.

g. Higher priority schedules shall overlay with lower priority schedules without interrupting or deleting them. Upon expiration of a higher priority schedule, schedule shall revert to next lower priority.

h. Expired priority 1 and priority 2 schedules shall be automatically deleted after execution.

10. Custom Application Programming:

a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.

b. Programming Features:

1) English oriented programming language, allowing for free form programming.

2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.

3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.

4) Allows the development of independently, executing, program modules designed to enable and disable other modules.

5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.

6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value;

minimum/maximum value from a list of values for mathematical functions.

8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.

9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.7 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:

1. User access secured via user passwords and user names.
2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts are recorded.
4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:

1. Weekly Schedules Based on Separate, Daily Schedules:
   a. Include start, stop, optimal stop, and night economizer.
   b. 10 events maximum per schedule.
   c. Start/stop times adjustable for each group object.
2. Exception Schedules:
   a. Based on any day of the year.
   b. Defined up to one year in advance.
   c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
3. Holiday or Special Schedules:
   a. Capability to define up to 99 schedules.
   b. Repeated annually.
   c. Length of each period is operator defined.

D. System Coordination: Provide a standard application for equipment coordination. The application shall provide the operator with a method of grouping together equipment based on function and location. Groups shall be capable of being used for scheduling and other applications.

E. Alarms:

1. Binary object is set to alarm based on the operator specified state.
2. Analog object to have high/low alarm limits.
3. All alarming is capable of being automatically or manually disabled.
4. Alarm Reporting:
    a. Operator determines action to be taken for alarm event.
    b. Alarms to be routed to appropriate workstation.
5. Reporting Action Options:
    a. Start Programs.
    b. Print.
    c. Logged.
    d. Custom messaging.
    e. Graphical displays.
    f. Dial out to workstation receivers via system protocol.

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation on the control drawings.

H. PID Control Characteristics:

1. Provide proportional-integral algorithms.
2. Direct or reverse action.
3. Anti-windup.
4. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
5. User selectable controlled variable, set-point, and PI gains.

I. Staggered Start Application:

1. Prevents all controlled equipment from simultaneously restarting after power outage.
2. Order of equipment startup is user selectable.

J. Anti-Short Cycling:

1. All binary output objects protected from short-cycling.
2. Allows minimum on-time and off-time to be selected.
3. Allows the number of times each piece of equipment may be cycled within any one-hour period.

K. On-Off Control with Differential:

1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.

2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

L. Trending: Building controllers shall allow collection and delivery of (time, value) pairs.

M. Totalization:

1. Run-Time Totalization:

a. Totalize run-times for all binary input objects.

b. Provides operator with capability to assign high run-time alarm.

c. Generates unique, user-specified messages when the limit is reached.

d. Resolution: Adjustable down to one minute.

2. Pulse Totalization:

a. Totalize consumption for user-selected analog and binary pulse input-type objects.

b. Configurable for a daily, weekly, or monthly basis.

c. Provide calculation and storage accumulations of up to 9,999,999 units (e.g. KWH, gallons, KBTU, tons, etc.).

d. Resolution: Adjustable down to one minute.

e. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

f. The information available from the Pulse Totalization shall include, but not be limited to, the following:

1) Peak Demand, with date and time stamp

2) 24-hour Demand Log

3) Accumulated KWH for day

4) Sunday through Saturday KWH usage

5) Sunday through Saturday Demand kW

6) Demand kW annual history for past 12 periods

7) KWH annual history for past 12 periods

3. Event Totalization:

a. Count user-selected events, such as the number of times a pump or fan system is cycled on and off.

b. Provide storage accumulations of up to 9,999,999 events before reset.

c. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring are installed prior to installation proceeding.

E. Verify the integrity of control wiring, raceways, control panels, sensors, and control devices prior to reusing for the new work.

F. Verify wiring insulation is defect free and test wiring for continuity and ground faults.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Coordination:

1. The BAS Contractor shall execute their work in such a manner as to cause the minimum interference to the operation of the building.

2. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

3. Where the BAS shall share a common network backbone via a VLAN, provide temporary network access for BAS construction, startup, and commissioning. Coordinate transition of network operation to Owner's IT group.

4. Coordinate with other contractors performing work to provide standby power to all control devices required to operate on standby power.

5. Coordinate with the Owner to display additional virtual points on individual schematic graphic screens that are not directly associated with that system. Examples may include outdoor air temperature or global alarm conditions.

C. Web Services Enabled Network:

1. Provide an IP network data drop for connection of BAS into Owner's IP network. Coordinate final location of IP network data drop with the Owners' IT staff.

2. If the Owner has no preference or not indicated on the drawings, locate data drop within the main BAS control panel.

3. Coordinate with the Owner's IT department to implement proper security measures, including secure access to the network data drop and firewalls at all virtual access points to the internet to protect access to the BAS.

D. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Install all equipment in readily accessible locations.
3. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Control wiring routed in wall cavities shall be installed in conduit.
6. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
7. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

E. Controllers:

1. Install controllers in a locked control panel. Provide common keying for all controller covers.
2. Provide a separate controller for each piece of controlled equipment, such as an AHU, FCU, VAV box, etc. A controller may control more than one piece of equipment provided that all points associated with the equipment are assigned to the same BAS controller. Global points used for control loop reset are exempt from this requirement.
3. Select building controllers and custom application controllers to provide the required I/O point capacity required to monitor all of the hardware points listed on the control drawings.
4. Application specific controllers may be used where factory programming is capable of executing all control functions specified in the sequences of operation. Contractor shall add supplemental controllers, devices, and programming as required to execute the specified control function if the ASC cannot.

F. Wiring:

1. All control and interlock wiring shall comply with national and local electrical codes.
3. Properly ground all controllers.
4. Wire all safety devices through both hand and auto positions of motor starting device to ensure 100 percent safety shut-off.
2. Provide interlock wiring between devices as indicated on the control drawings.
3. Provide electrical wiring for relays (including power feed) for temperature and pressure indication.
4. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
5. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.

6. Conceal all low voltage wiring in finished rooms.

7. Conceal all low voltage wiring in unfinished rooms below the elevation of the lights. Low voltage wiring above the elevation of the lights may be exposed.

8. Routing of low voltage wiring above working heights in equipment rooms and above accessible ceilings is acceptable subject to following criteria:

   a. Wiring shall be plenum rated.

   b. Do not lay wiring on ceiling tiles.

9. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended applications.

10. All wiring in mechanical, electrical, service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.

11. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two wires (e.g., relays and transformers).

12. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.

13. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

14. All wire-to-device and wire-to-wire connections shall be made at a terminal block or terminal strip.

15. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

16. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, coordinate with Division 26 to provide step-down transformers.

17. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

18. Install plenum wiring in sleeves where it passes through floors and walls. Maintain fire rating at all penetrations.

19. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

20. Include one pull string in each raceway 1 inch and larger.

21. Use coded conductors throughout with conductors of different colors.

22. Control and status relays shall be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

23. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g., steam pipes or flues).

24. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

25. Install insulated bushing on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

26. Terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.

27. Terminate BAS sensor input wiring cable shield by taping back at the field device and connect shield to the grounded control panel chassis or sub-panel.

28. Terminate BAS comm bus cable shield between controllers per manufacturer recommendations.

29. Terminate management level/enterprise level network wiring cable shield by wrapping the drain wire around the foil shield and connecting the ground strip to the drain wire.

30. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than 1/2 inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

31. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

G. Communication Wiring:

1. Adhere to the items listed in the “Wiring” article in Part 3 of this specification in addition to the requirements listed below.

2. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer’s installation recommendations for all communication wiring.

3. Do not exceed 328 feet in Ethernet wiring length between switches or repeaters.

4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

5. Do not install power wiring, in excess of 30 Vac RMS, in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, use separate twisted shielded pairs with the shields grounded in accordance with the manufacturer’s wiring practice.

6. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.

7. Do not exceed maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer during installation.

8. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

9. When a cable enters or exits a building, install a lightning arrestor between the lines and ground. Install the lightning arrestor according to the manufacturer's instructions.

10. Ground (earth ground) all shields at one point only, to eliminate ground loops.

11. All runs of communications wiring shall be unspliced length when that length is commercially available.

12. Terminate shielded cable splices in accessible locations. Harness cables with cable ties.

13. Make all wire-to-device and wire-to-wire connections at a terminal block or terminal strip.

14. Label all communications wiring to indicate origination and destination data.

15. Ground coaxial cable in accordance with NEC regulations.

16. Install BACnet MS/TP communications wiring in accordance with ASHRAE/ANSI Standard 135

    a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 17 pF per foot at 76,800 Baud.

    b. The maximum length of an MS/TP segment shall be 3000 ft with AWG 22 or 24 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.

    c. The maximum number of nodes per segment shall be 50. Additional nodes may be accommodated by the use of repeaters.

    d. An MS/TP EIA-485 network shall have no T connections.

H. Identification of Hardware and Wiring:

1. Label all wiring and cabling, including that within factory-fabricated panels, at each end within 2 inch of termination with the BAS address or termination number.

2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.

4. Identify all other control components with permanent labels. Label all plug-in components such that removal of the component does not remove the label.

5. Identify room sensors related to terminal box or valves with nameplates.

6. Maintain manufacturers' nameplates and UL or CSA labels visible and legible after equipment is installed.

7. Identifiers shall match record documents.

3.3 STARTUP AND DEMONSTRATION

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing the BAS in permanent operation.

B. Contractor shall provide an on-site controls technician or programmer familiar with the project BAS installation and system programming to assist the Commissioning Agent as directed during all phases of system functional testing.

C. Coordinate with Owner the setup of logins, passwords, and security level access for individuals requiring access to the BAS.

B. BAS graphics shall be updated with final equipment names, equipment numbers, room names and room numbers to match the final construction documents and any Owner changes made prior to occupancy.

D. BAS shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the BAS equipment used in this project. Technicians shall be experienced in the type of HVAC systems associated with this project.

E. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

F. Test each control device to ensure that it is operating properly and is calibrated to the appropriate operating requirements. Run each control device through its range of operation and sequence. Verify all normal positions are correct. Adjust and tune PID control constants to achieve proper system operation.

1. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

2. Demand limiting. The Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

3. Optimum start/stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

4. Any tests that fail to demonstrate the operation of the BAS shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

G. Test and verify control interfaces to other building systems integrated into the network.

H. Verify all alarms and interlocks.

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

4. Verify fire/smoke and smoke damper functionality. Verify that they respond to the proper fire alarm system general, zone, and/or detector trips.

I. Document on system equipment schedules the final setting of controller PID constant settings, setpoints, manual reset values, maximum and minimum controller output, and ratio and bias settings in units and terminology specific to the controller. Store documentation with operator workstation.

J. Demonstrate complete and operating system to Owner.

1. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process.

3. The Contractor shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Any test equipment required to provide the proper operation shall be provided by and operated by the Contractor.

4. Demonstrate compliance with sequences of operation through all modes of operation.

5. Demonstrate complete operation of operator interface.

K. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Contractor and submitted for approval by the Owner. Such tests shall then be performed as part of the warranty.

2. The BAS shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.4 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of sixteen hours on the operation and maintenance of the equipment provided under this section.

B. Organize the training into sessions or modules for different levels of operators. Owner designated personnel shall be trained based on the level of operator training described below.

C. Day-to-day Operator Training:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Proficiently operate the BAS.
3. Understand BAS architecture and configuration.
4. Understand BAS components.
5. Understand system operation, including BAS control and optimizing routines (algorithms).
6. Operate the workstation and peripherals.
7. Log on and off the system.
8. Access graphics, point reports, and logs.
9. Adjust and change system set points, time schedules, and holiday schedules.
10. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
11. Understand BAS drawings and Operation and Maintenance manual.
12. Understand the job layout and location of control components.
13. Access data from BAS controllers and ASCs.
14. Operate portable operator's terminals.
15. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

D. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

E. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

F. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 230923

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.

B. Hydronic piping materials.

C. Hydronic piping fittings.

D. Hydronic piping joining materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Reference Division 23 Section, “Basic Piping Materials and Methods” for additional submittal requirements.

C. Reports as specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Comply with Division 23 Section, “Basic Piping Materials and Methods.”

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this Section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division 23 Section, “Basic Piping Materials and Methods.”

PART 2 - PRODUCTS

2.1 HYDRONIC PIPING MATERIALS

A. Carbon Steel Pipe:

1. NPS 2 inch and Smaller: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain ends.
2. NPS 2-1/2 inch through 10 inch: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain or beveled ends.
3. NPS 12 inch and Larger: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule STD, black steel, plain or beveled ends.

B. Copper Tubing:

1. Drawn Temper Tubing: ASTM B88, Type L.

2.2 HYDRONIC PIPING FITTINGS:

A. General: Fittings shall be of wall thickness, pressure rating, and material matching adjoining pipe.

B. Reference Division 23 Section "Basic Piping Materials and Methods" for basic piping materials and fittings.

C. Threaded:

1. All threads shall conform to ASME B1.20.1.
2. Malleable-Iron: ASME B16.3, standard pattern.
3. Cast-Iron: ASME B16.4, standard pattern.
4. Galvanized: ASTM A197, standard pattern.

D. Flanged:

1. Cast-Iron Threaded: ASME B16.1, raised ground face, bolt holes spot faced.
2. Cast-Bronze Flanges: ASME B16.24, raised ground face, bolt holes spot faced.
1. Galvanized Threaded: ASME B16.5, raised ground face, bolt holes spot faced.
3. Wrought Cast-Iron, Forged Steel, and Stainless Steel: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connection, and facing:
    a. Material Group: 1.1.
    b. End Connections: Butt welding.
    c. Facings: Raised face.
4. Gaskets: ASME B16.21, non-metallic, asbestos free, 1/8 inch thick, full-face for cast-iron flanges and raised-face steel flanges, suitable for chemical and thermal conditions of piping system contents.
5. Flange bolts and nuts: ASME B18.2.1, hex head carbon steel according to ASTM A307, Grade B.

E. Welded:

1. Carbon and Galvanized Steel: ASME B16.9, seamless weld conforming to ASTM A234.

F. Solder-Joint: Wrought-copper, ASME B16.18 or B16.22, streamlined pattern.

G. Brazed-Joint: Wrought-copper, ASME B16.50, streamlined pattern.

2.3 HYDRONIC PIPING JOINING MATERIALS:

A. Reference Division 23 Section "Basic Piping Materials and Methods" for basic joining materials.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install piping to ASME B31.9 requirements.

C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

3.2 PIPE APPLICATION SCHEDULE

A. Mechanically Joined Hydronic Piping:

B. Heating Hot Water Piping, Above Grade:

1. Acceptable Pipe Materials:

   a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.

   b. Type L copper with soldered, brazed, or flanged fittings.

2. Fitting Pressure Class: Minimum rating of 150 psig.

3.3 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment using jointing system specified.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.4 PIPING INSTALLATION

A. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.

B. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

C. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

D. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.

1. Tee-drilling is prohibited as a means for connecting branch taps into any main.

2. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.

E. Anchor piping to ensure proper direction of expansion and contraction.

3.5 PIPE HANGERS AND SUPPORTS APPLICATION

C. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

A. Provide vibration isolation on piping as specified in Division 23 Section "Vibration Isolation for HVAC."

B. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	1/2
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8 (1/2 for copper)
5	16	13	5/8 (1/2 for copper)
6	17	14	3/4 (5/8 for copper)
8	19	16	3/4
10	22	18	7/8 (3/4 for copper)
12	23	19	7/8 (3/4 for copper)
14	25		1
16	27		1
18	28		1 1/4
20	30		1-1/4
24	32		1-1/4
30	33		1-1/4

C. Use copper tube maximum hanger span requirements for PVC and CPVC supports and hangers, unless manufacturer's recommendations specify closer hanger spacing.

D. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.

E. Install a support within one foot of each change of direction.

F. Space supports not more than five feet apart at valves, strainers, or piping accessories in piping larger than 2 inches.

3.6 PIPE JOINT CONSTRUCTION

A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.

B. Where more than one pipe material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.

C. Install non-conductive dielectric connections whenever joining dissimilar metals.

D. Pipe-to-Valve and Pipe-to-Equipment Connection: Install flanges or unions between piping and valves and equipment for servicing. Do not use direct welded, brazed, or soldered connections unless specifically called for in the manufacturer's installation instructions.

3.7 FIELD QUALITY CONTROL

A. Preparation for Testing:

1. Prepare hydronic piping in accordance with ASME B31.9.
2. Leave joints, including welds, uninsulated and exposed for examination during the test.
3. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

B. Pressure Testing:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

4. Subject piping system to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leaks. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

6. Provide test reports summarizing the test procedures and results of the tests.

C. Flushing:

1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.

2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.

3. Isolate new pipe from existing pipe during flushing.

4. Provide temporary valves, connections, and bypasses where required.

5. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.

6. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.

7. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.

8. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

D. Fluid Testing: After filling the system as described under Paragraph “Startup”, perform the following fluid test procedures:

1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.

2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or glycol. Coordinate with the testing agency for amount of sample needed for proper testing.

3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage and repeat the circulation and testing procedures specified above. Coordinate with the water treatment supplier.

4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.

5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

3.8 ADJUSTING AND CLEANING

A. After installation of entire system, fill, clean, and treat systems. Refer to Section "HVAC Water Treatment" for additional requirements.

B. Cleaning Agent Concentration:

1. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

C. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.
3. Refill with clean water and circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

D. Chilled Water and Closed Loop Condenser Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.
3. Refill with clean water and repeat until system cleaner is removed.

E. Open Loop Systems:

1. Flush open systems with clean water for one hour minimum. Drain completely and refill.

F. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

G. Remove and clean or replace strainer screens.

H. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

I. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

J. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

K. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

L. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.9 STARTUP

A. Fill system and perform initial chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check pump for proper direction of correct improper wiring.
4. Set automatic fill valves for required system pressure.
5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Check operation of automatic bypass valves.
8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
9. Lubricate motors and bearings.

END OF SECTION 232113

SECTION 232113.23 - MECHANICALLY JOINED HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanically joined piping system requirements.

B. Carbon steel grooved piping system.

C. Copper grooved piping system.

D. Copper press-fit piping system.

E. Carbon steel plain end piping system.

F. Carbon steel press fit piping system.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Reference Division 23 Section, “Basic Piping Materials and Methods” for additional submittal requirements.

C. Shop Drawings:

1. Indicate grooved-joint couplings and fittings on drawings and product submittals, and specifically identify with the applicable style or series designation.

2. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.

D. Maintenance Data: Include for each piping specialty and valve in Maintenance Manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

E. Reports as specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

F. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 23 section "Basic Piping Materials and Methods".

G. Submit training certificate of completion for each worker to engineer of record within 30-days of mobilization. Include copy of each worker's training certificate of completion with closeout documents.

1.4 QUALITY ASSURANCE

A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

A. Single Source Responsibility: All components of each mechanically joined piping system used shall be of one manufacturer and conform to local code approval.

B. Grooving and Joining Tools: Approved by the mechanically joined piping system manufacturer for use with their system and furnished by one manufacturer, though not necessarily the same as the grooved component manufacturer.

C. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this Section, with minimum three years of documented experience and ISO 9001 certification.

1. Date stamp all castings used for coupling housings, fittings, etc. for quality assurance and traceability.

D. Installer Qualifications:

1. Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

E. Obtain installation training from the mechanically joined piping manufacturer for all workers that will be installing or handling the mechanically joined piping components per Part 3 "Field Quality Control". Maintain a copy of each worker's training certificate of completion on site for the duration of the project.

F. Pipe, fittings, and specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.

1.5 COORDINATION

A. Reference Division 23 Section "Hydronic Piping" for coordination and additional hydronic piping material and execution requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

B. Comply with Division 23 Section "Basic Piping Materials and Methods."

PART 2 - PRODUCTS

2.1 MECHANICALLY JOINED PIPING SYSTEM REQUIREMENTS

A. Pipe Materials:

1. Refer to the specific product sections in Part 2 for the acceptable pipe materials.

B. Fittings:

1. General: Fittings shall be of wall thickness, pressure rating, and material compatible with adjoining pipe as listed and approved by the manufacturer's current literature for the piping system used.

2. Reference Division 23 Section "Basic Piping Materials and Methods" for additional fittings.

3. Grooved:

a. All grooved joints shall be full-flow type and conform to AWWA C606 and ASTM F1476.

1) Victaulic Advanced Groove System (AGS) pipe ends are an acceptable alternate.

b. Body Materials:

1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15.

2) Wrought Steel: Comply with ASTM A234, Grade WPB, 0.375 inch wall.

3) Carbon Steel: Comply with ASTM A53, Grade B or ASTM SA352, Grade LCC.

4) Wrought copper: Comply with ASTM B75 Alloy C12200 or ASTM B152 Alloy C1100.

5) Bronze Sand Cast: Comply with ASTM B16.18 and B584 ally UNS C89836.

c. Coating: Suitable enamel, epoxy, or hot-dipped galvanized according to ASTM A153 to match system requirements.

4. Strapless Outlet Fittings:

a. Pipe Strapless Outlets: 1/2 inch or 3/4 inch NPT outlet for use on 4 inch and larger pipe sizes, rated for 300 psig.

1) Housing: Ductile iron housing conforming to ASTM A536, Grade 65-45-12, painted black.

2) Collar: Hot rolled steel collar conforming to ASTM A569, zinc electroplated to ASTM B633.

3) Bushing: Brass conforming to UNS C37700.

4) Seat/Liner Gasket: Same as Grooved Joint Gasket requirements specified under article "Joining Materials."

b. Press-In Branch Connector: 3/4 inch FNPT outlet for use on 1-1/2 inch through 6 inch Schedule 40 carbon steel pipe.

1) Fitting: Carbon steel per ASTM A420 with corrosion resistant coating of zinc/nickel or equal.

2) Thread: Conform to ASME B1.20.1.

3) Sealing Element: EPDM or FKM seal.

4) Working Pressure: 200 psig.

5. Test Caps: Ductile iron cap according to ASTM A536, Grade 65-45-12, suitable for use on metallic IPS pipe with integral NPT ball valve, maximum test pressure of 250 psi and maximum test temperature of 110 degrees F. Victaulic T-60 test cap or approved equal.

6. Press-Fit:

a. Press-Fit fittings shall comply with ASME B16.51, ASME B31.1 or ASME B31.9 as applicable for the material and project.

b. Press-Fit fittings shall comply with ASTM F3226.

c. Press-fit fittings shall include self-contained O-ring seals in the end connections.

d. Provide leak feature integral to the fitting body to detect unpressed fittings during the pressure testing process.

e. Body Materials:

1) Wrought Copper: Comply with ASTM B75 Allow C12200 or ASTM B152 Alloy C11000.

2) Cast Copper: Comply with ASTM B584 Alloy C84400, C87600 or C87710.

3) Carbon Steel: Comply with ASTM A420 and have corrosion resistant zinc/nickel or equal coating.

f. End Connections:

1) Threaded: All threads shall conform to ASME B1.20.1.

2) Solder-Joint: Wrought-copper, ASME B16.18 or B16.22, streamlined pattern.

3) Flared Ends: Comply with ASME B16.26.

C. Joining Materials:

1. Reference Division 23 Section “Basic Piping Materials and Methods” for basic joining materials.

2. Joining Tools: Approved by the mechanically joined piping system manufacturer for use with their system.

3. Grooved Couplings: Multi-piece housing attached with bolts and nuts with pressure responsive elastomeric gasket, constructed of material specified under Article “Fittings” above and of the following styles.

a. Rigid Couplings: Designed with offsetting angle bolt pads to provide a rigid pipe joint to restrict axial or angular movement.

b. Flexible Couplings: Designed with flat bolt pads to provide a flexible pipe joint and accommodate a limited amount of linear and/or angular movement.

c. Reducing Couplings: Designed to include a direct pipe reduction on pipe run without additional components and includes steel washer to prevent telescoping of smaller pipe inside the larger pipe during a vertical system assembly.

d. HDPE Couplings: Housing shall include gripping teeth which bite into the entire circumference of the pipe.

4. Coupling Bolts: Track-head type and constructed of the one of the following:

a. Type 304 or 316 stainless steel conforming to ASTM A193, Grade B8/B8M, Class 2 or ASTM F593 and F594, Group 2, Conditions CW.

b. Heat treated carbon steel conforming to ASTM A183 and A449, zinc electroplated to ASTM B633, with a minimum tensile strength of 110,000 psi.

5. Nuts: Heavy-duty hexagonal type conforming to ASTM A563, Grade B or ASTM A194, Grade 8M.

6. Washers: Flat type, plated carbon steel conforming to ASTM F436 or Type 304 or 316 stainless steel.

7. Grooved-Joint Gaskets:

a. Molded synthetic rubber (EPDM compound) with central cavity and pressure responsive configuration, integral pipe stop, and complying with ASTM D2000, Grade 2CA615A25B24F17Z.

b. Gasket Grade: Type “E” or “EHP” for hydronic applications. Coordinate the appropriate gasket grade with the manufacturer for other applications.

c. Identification: Tagged with the appropriate color code to indicate the application.

d. Temperature operating range: -30 degrees F to +230 degrees F.

8. Flange Adapters:

a. Cast-Bronze Flanges: ASME B16.24, raised ground face, bolt holes spot faced.

b. Wrought Cast-Iron, Forged Steel, and Stainless Steel: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connection, and facing:

1) Material Group: 1.1.

2) Facings: Raised face.

c. Gaskets: ASME B16.21, non-metallic, asbestos free, 1/8 inch thick, full-face for cast-iron flanges and raised-face steel flanges, suitable for chemical, thermal, and dielectric conditions of piping system contents.

d. Flange bolts and nuts: ASME B18.2.1, hex head carbon steel according to ASTM A307, Grade B.

9. Pipe Transition Adapters:

   a. Constructed of material, size, and end connection to join different pipe materials or joining methods.

   b. Adapter shall be listed according to the manufacturer's literature for the application and joining methods.

   c. Reference Division 23 Section "Basic Piping Materials and Methods" for dielectric fittings.

10. Press Couplings: Single-piece housing with self-contained O-ring seals in the end connections. O-ring seals shall comply with the following:

    a. EPDM compound conforming to ASME B16.51.

    b. Type "E" EPDM compound complying with ASTM D2000, Grade 2CA615A25B24F17Z.

    c. Identification: Tagged with the appropriate color code to indicate the application.

    d. Temperature operating range: -30 degrees F to +230 degrees F.

11. Press Fit Sealing Elements

    a. Peroxide cured EPDM or FKM elastomeric seal.

    b. EPDM rated for 0 to 250 degrees F, FKM rated for 15 to 285 degrees F.

    c. Uniform in size and width and free from manufactured deformities or indentions.

D. General Duty Valves and Hydronic Specialties:

1. Acceptable manufacturers listed within this specification may have comparable products which comply with the product specifications referenced in the sections below. These products are acceptable provided they meet the specified requirements and are compatible with the piping system. Reference the Valve and Hydronic Specialties Schedule in Part 3 for examples of acceptable products and design intent. Refer to manufacturer's current literature for comparable products, sizes, pressure ratings, and connection methods compatible with the piping system. Products identified by model number are based on available size and pressure ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.

2. Reference Division 23 Section "General Duty Valves for HVAC Piping" for general duty valve requirements.

3. Reference Division 23 Section "Hydronic Specialties" for hydronic specialty requirements.

E. Expansion Joints:

1. Reference Division 23 Section "Expansion Fittings and Loops for HVAC" for expansion joint requirements.

2. Select expansion joint and support method in accordance with design conditions and performance data published in manufacturer's literature using the following types:

a. Slip Type: Victaulic Style 150 Mover telescoping slip type or approved equal.

b. Standard Expansion Type: Style 155 expansion joint consisting of a series of flexible couplings joined in tandem or approved equal.

2.2 CARBON STEEL GROOVED PIPING SYSTEM

A. Manufacturers:

1. ASC Engineered Solutions.
2. Shurjoint Piping Products.
3. Victaulic.

B. Carbon Steel Pipe:

1. NPS 10 inch and Smaller: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain ends.
2. NPS 12 inch and Larger: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule STD, black steel, plain ends.

2.3 COPPER GROOVED PIPING SYSTEM

A. Manufacturers:

1. ASC Engineered Solutions.
2. Shurjoint Piping Products.
3. Victaulic.

B. Copper Tubing:

1. Copper Tube Size (CTS), ASTM B88 Type L, hard-drawn.

2.4 COPPER PRESS-FIT PIPING SYSTEM (CTS)

A. Manufacturers:

1. ASC Engineered Solutions “Gruvlok.”
2. Apollo “Xpress”.
3. Mueller Streamline PRS.
4. NIBCO, Inc., Press System.
5. Viega, ProPress.

B. Copper Tubing:

1. CTS 3/4 inch through 4 inch: ASTM B88 Type L, hard-drawn.

2.5 CARBON STEEL PLAIN END PIPING SYSTEM

A. Manufacturers:

1. Victaulic, Quick-Vic Installation Ready.

B. Carbon Steel Pipe:

1. NPS 3/4 inch through 2 inch: ASTM A53 or A106, Schedule 40, plain ends.

2.6 CARBON STEEL PRESS FIT PIPING SYSTEM

A. Manufacturers:

1. Apollo PowerPress.
2. Mueller Streamline STL.
3. NIBCO BenchPress.
4. Viega, MegaPress

B. Carbon Steel Pipe:

1. NPS 3/4 inch through 2 inch: ASTM A53 or A106, Schedule 40, press-fit ends.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install piping to ASME B31.9 requirements.

C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

D. Reference Division 23 Section "General Duty Valves for HVAC Piping" for general duty valve installation requirements.

E. Reference Division 23 Section "Hydronic Specialties" for hydronic specialty installation requirements.

3.2 PIPE APPLICATION SCHEDULE

A. Heating Hot Water System:

1. Carbon Steel Grooved: 2 inch and larger.
2. Copper Grooved: 2 inch through 8 inch.
3. Copper Press-Fit: 3/4 inch through 4 inch.
4. Carbon Steel Plain End: 3/4 inch through 2 inch.
5. Carbon Steel Press Fit End: 3/4 inch through 2 inch.
6. Fitting Pressure Class: Minimum rating of 150 psig.

B. Use stainless steel couplings and fittings where design conditions require the use of non-ferrous piping materials for both interior and exterior piping surfaces.

3.3 PREPARATION

A. Remove scale and dirt on inside and outside before assembly.

B. Verify pipe and tube ends are free from indentations, projections, and roll marks in the area from tube end to groove from proper gasket sealing.

C. Prepare piping connections to equipment using jointing system specified.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.4 PIPING INSTALLATIONS

A. Hydronic piping installations shall be installed subject to Division 23 Section "Hydronic Piping" in addition to those requirements specified in this Section.

3.5 PIPE HANGERS AND SUPPORTS APPLICATION

A. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.6 PIPE JOINT CONSTRUCTION

A. Reference Division 23 Section "Basic Piping Materials and Methods" for basic pipe joint construction.

B. Where more than one pipe material is specified, provide joining fittings or pipe transition adapters with appropriate dielectric isolation that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.

C. Grooved Joints:

1. Ream, debur, and clean tube ends and verify they are free from indentations, projections and roll marks in the area from tube end to groove for proper gasket sealing.

2. Roll and cut groove ends in accordance to manufacturer's current listed standards and according to AWWA C606. Use rolls sets designed and intended for use on the appropriate pipe material when grooving pipe.

    a. Victaulic Advanced Groove System (AGS) pipe ends are an acceptable alternate. If Victaulic AGS grooved system is used, all couplings, adapters, fittings, and valves shall be compatible with AGS grooved ends.

    b. Do not use cut groove ends in copper tubing, roll groove only.

    c. Do not use cut groove ends in stainless steel pipe, roll groove only.

3. Verify tolerances of and maintain grooving tool components for duration of grooving processes. Replace grooving tool components that are found out of tolerance with new as required.

4. Flaring of CTS tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

5. Verify the gasket style and elastomeric material (grade) is suitable for the intended service as specified and in combination with any system chemical additives.

6. Reference latest published manufacturer's product data for additional pressure ratings and application information.

7. Reference the latest published of manufacturer's field installation instructions or other included installation instruction prior to attempting assembly.

8. Install gaskets with lubricant suitable for all piping services. Lubricant shall be by one manufacturer.

D. Press-Fit Joints:

1. Install press piping system in accordance with manufacturer's recommendations.

2. Ream, debur, and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.

3. Install permanent inspection mark on tube.

4. Clean tube and fittings of all dirt and oil. Verify O-ring and all press connection components are in place and free of oil, grease or dirt.

5. Push pipe or tube into fittings with twisting action to all the way to the fitting stop or shoulder.

6. Mark tube with permanent marker to indicate proper tube insertion depth.

7. Verify press tool has correct size jaw set for tube size used.

8. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.

9. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.

10. Squeeze jaw open to remove the tool and observe witness mark.

11. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.

12. Maintain minimum distance between joints per the manufacturer's published installation instructions.

13. Perform pressure test for unpressed fitting detection per manufacturer's installation instruction prior to final pressure test.

E. Dielectric Isolation Requirements: Refer to Division 23 Section "Basic Piping Materials and Methods" for dielectric fittings and their installation requirements. Provide dielectric flanges, flange kits, or dielectric transition couplings for the following joint types:

1. Flange Adapters to Iron, Ductile Iron or Steel Body Valves or Fittings (Except Butterfly Valves): Provide full face gaskets between flanges and adapter flanges. At each bolt, provide steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.

2. Flange Adapters to Butterfly Valves in Series with Iron, Ductile Iron or Steel Body Valves or Fittings: At each bolt, provide stainless steel washers, thermoplastic

washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide stainless steel bolts on butterfly valve flange.

3. Flange Adapters to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.

4. Dielectric Transition Couplings: Provide dielectric transition coupling when connecting copper pipe to butterfly valves. Provide dielectric transition coupling when connecting grooved IPS pipe to CTS pipe.

F. Couplings:

1. Install rigid couplings unless noted otherwise.

2. Install flexible couplings at locations required to accommodate expansion and/or vibration isolation.

   a. Install flexible couplings at pumps.

   b. Install flexible couplings at expansion joints.

   c. Install three flexible couplings at mechanical equipment connections for noise and vibration reduction in lieu of flexible connectors if preferred.

3. Install reducing couplings at reductions in pipe size.

4. Install press couplings in conjunction with the appropriate press piping system.

G. Flange Adapters:

1. Install flange adapter washers when flange adapters are used against the following surfaces:

   a. Rubber.

   b. Adapting to ANSI/AWWA cast flanges.

   c. Rubber faced lug valves.

   d. Serrated flanged surfaces.

2. Do not install flange adapters for applications that incorporate tie rods for anchoring or on standard grooved-end fittings within 90 degrees of each other.

H. Miscellaneous Connections:

1. Install test caps for temporary use during piping system testing activities. Test caps shall not be permanently installed in the piping system.

2. Test caps may be reused within the maximum test pressure and provided the product remains undamaged. Inspect and verify the suitability for service of all test caps prior to installation and use.

3. Connect test caps to piping system with Victaulic Style 107V or equivalent rigid coupling.

4. Test cap may be used for filling, testing, or draining purposes by connecting to the NPT outlet of the integral ball valve.

5. Install blind flanges with separate means to fill, test, or drain system for testing if test caps are not available from manufacturer.

3.7 VALVE AND HYDRONIC SPECIALTIES SCHEDULE

A. Reference Division 23 Section "General Duty Valves for HVAC Piping" for general duty valve applications.

B. Valve and Hydronic Specialties Schedule: The following schedule references Victaulic model numbers, except where another manufacturer is noted. Manufacturers and model numbers represent examples of acceptable products and design intent.

1. Carbon Steel Grooved Piping System:

Valve or Specialty Type	Model/Series Number
Iron Ball Valve	726
Iron Butterfly Valve	761
Iron Swing Check	712
Iron Lift Check	716
Iron Venturi Check	779
Balancing Valve	785 through 789
Coil Kits	799 or 79V
T-Strainer	730
Y-Strainer	732
Suction Diffuser	731

2. Copper Grooved Piping System:

Valve or Specialty Type	Model/Series Number
Brass Butterfly Valve	608N

3. Copper Press-Fit Piping System:

Valve or Specialty Type	Model/Series Number
Bronze Ball Valve	Hammond 8303A P2
	Milwaukee #BA-400S-P2
	Nibco PC585-70-66
Bronze Gate Valve	Hammond IB640 P2
	Milwaukee #105 P2
	Nibco PF111
Bronze Globe Valve	Hammond IB440 P2
	Milwaukee 502 P2
	Nibco PF211
Bronze Swing Check	Hammond 509Y P2
	Milwaukee 509Y P2
	Nibco PF413

4. Carbon Steel Press-Fit Piping System:

Valve or Specialty Type	Model/Series Number
Carbon Steel Ball Valve	Viega 4870

3.8 HYDRONIC SPECIALTIES INSTALLATION

A. Reference Division 23 Section "Hydronic Piping Specialties" for product requirements.

B. Strainers:

1. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.

2. Provide press to connect adapter flanges for 2-1/2 inches to 4 inches.

3. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

3.9 EQUIPMENT CONNECTIONS

A. Grooved flexible style couplings may be used at equipment connections where specified for vibration isolation control only.

B. Press to connect joints shall not be provided for equipment connections. Provide flanges, unions, di-electric unions or waterway fittings. Flanges, unions, di-electric unions and waterway fittings are specified in Division 23 Section "Basic Piping Materials and Methods."

3.10 FIELD QUALITY CONTROL

A. Reference Division 23 Section "Hydronic Piping" for field quality control requirements in addition to those specified herein.

B. The mechanically joined piping system manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving and joining tools and installation of mechanically joined piping products.

C. Installing contractor shall schedule certification training session with the mechanically joined piping component manufacturer, or manufacturer's representative, for all workers that will be installing or handling the mechanically joined piping systems Training shall cover the proper use of mechanically joining tools and installation of mechanically joined piping products. Mechanically joined piping component manufacturer, or manufacturer's representative shall provide a certificate of completion for each attending worker.

D. Mechanically joined piping supplier shall provide certification training to Contractor without cost and without additional cost to Owner.

E. Provide testing procedures as defined in Division 23 Section "Hydronic Piping" and as specified in mechanically joined piping manufacturer's installation instructions.

F. The mechanically joined manufacturer's factory trained representative shall periodically visit the jobsite and review the installation to verify that the contractor is following best recommended practices in grooved product installation.

G. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for substantial completion review as defined in Division 23 Section "Common Work Results for HVAC."

H. Workers performing mechanically joined joints shall initial each joint with a permanent ink marker, such as a "Sharpie". Initials shall be block letters with a minimum height of 1/4".

3.11 ADJUSTING AND CLEANING

A. Reference Division 23 Section "Hydronic Piping" for adjusting and cleaning procedures.

3.12 STARTUP

A. Reference Division 23 Section “Hydronic Piping” for startup procedures.

END OF SECTION 232113.23

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Moisture and liquid indicators.

C. Valves.

D. Strainers.

E. Check Valves.

F. Pressure regulators.

G. Pressure relief valves.

H. Filter-driers.

I. Solenoid valves.

J. Expansion valves.

K. Receivers.

L. Flexible connections.

1.2 SUBMITTALS

A. Product Data: Provide general assembly of valves and specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.

B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment.

C. Test reports specified in Part 3 below.

D. Manufacturer's Installation Instructions: Indicate support requirements, connection requirements and isolation requirements for servicing.

E. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.

F. Maintenance Data: Include maintenance instructions for refrigerant valves and piping specialties, for inclusion in Operation and Maintenance manual.

1.3 QUALITY ASSURANCE

A. Comply with Division 23 Section, “Basic Piping Materials and Methods.”

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, and maintain sealed until connected into system.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Comply with ASME/ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.

B. Comply with ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration

C. Comply with applicable Mechanical Code.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.2 PIPING

A. Copper Tubing:

1. ASTM B280, Type ACR, seamless, hard-drawn straight lengths and soft-annealed coils. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.
2. ASTM B88, Type L, seamless, hard-drawn straight lengths and soft-annealed coils.
3. ASTM B88, Type K, seamless, hard-drawn straight lengths and soft-annealed coils.

B. Refrigerant Line Kits:

1. Type ACR seamless copper roll of refrigerant tubing with pipe diameters as recommended by the manufacturer and of length as required for the installation.
2. Factory or field installed flexible unicellular insulation:
    a. Minimum thickness as required per Division 23 section “HVAC Insulation”.
3. Quick-connect flare tubing compression fittings or solder connections as required to match the connections of the condensing unit and evaporator coil.

2.3 FITTINGS

A. Wrought-Copper Fittings for Solder-joint: ANSI B16.22, streamlined pattern.

B. Mechanical Flared Fittings: ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tube.

2.4 JOINING MATERIALS

A. Refer to Division 23 Section “Basic Piping Materials and Methods” for joining materials.

2.5 PIPE SUPPORTS

A. Hanger, supports, and anchors are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing. Provide plastic galvanic isolators for copper tubing where indicated.

2.6 MOISTURE AND LIQUID INDICATORS

A. Manufacturers

1. Emerson Electric.
2. Henry Technologies.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Moisture/liquid Indicators: Single port type, UL listed, with forged brass body, solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; rated for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.7 SHUT OFF VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Henry Technologies.
4. Parker Hannifin/Refrigeration and air Conditioning.
5. Sporlan, Division of Parker Hannifin.

B. General: Complete valve assembly shall be UL-listed and designed to conform to AHRI 760. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

C. Diaphragm Packless Valves: Globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel

spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F

D. Ball: Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seal; maximum working pressure 500 psig and maximum temperature of 275 F.

E. Globe: Cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections; for maximum working pressure of 500 psig and maximum operating temperature of 275 deg. F.

2.8 STRAINERS

A. Manufacturers:

1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

B. Strainers: 500 psig maximum working pressure; forged brass body with Monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

2.9 CHECK VALVES

A. Manufacturers:

1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

B. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze or forged brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.

C. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

2.10 PRESSURE REGULATING VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Evaporator Pressure Regulating Valves: Pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tappings, 24 volts DC, 50/60 Hz, standard coil; and wrought copper fittings for solder end connections.

2.11 PRESSURE RELIEF VALVES

A. Manufacturers:

1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.12 FILTER DRIERS

A. Manufacturers:

1. Danfoss.
2. Emerson Electric
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows:

1. Standard capacity desiccant sieves to provide micronic filtration.
2. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

C. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

D. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets.

2.13 SOLENOID VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.

4. Sporlan, Division of Parker Hannifin.

B. Valves: 250 deg. F temperature rating, 500 psig working pressure; forged brass body, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve.

C. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.

2.14 ELECTRONIC EXPANSION VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

B. Valve: Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

C. Evaporation Control System: Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.15 RECEIVERS

A. Manufacturers

1. Henry Technologies.
2. Parker Hannifin/Refrigeration and air Conditioning
3. Sherwood Valve/Harsco Corporation
4. Sporlan, Division of Parker Hannifin

B. Internal Diameter 6 inch and Smaller: AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

C. Internal Diameter Over 6 inch: AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.16 FLEXIBLE CONNECTORS

A. Manufacturers

1. Danfoss.

2. Parker Hannifin/Refrigeration and air Conditioning

3. Sporlan, Division of Parker Hannifin

B. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length

PART 3 - EXECUTION

3.1 PIPE APPLICATION SCHEDULE

A. Above Grade:

1. Type L or Type ACR tubing.

B. Below Grade and Within Slabs:

1. Use Type K tubing for 2 inch and smaller without joints. Mechanical fittings (crimp or flare) are not permitted.

2. Install tubing in insulated PVC or HDPE protective conduit. Vent conduit to the outdoors.

C. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "CLEANING" below.

D. At contractor's option, use refrigerant line kits for refrigerant systems of 5 tons and smaller capacity.

3.2 PIPE IDENTIFICATION

A. Reference Division 23 Section "Identification for HVAC Piping and Equipment" for piping identification requirements.

3.3 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install piping to ASME B31.9 requirements.

C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

D. Do not install PVC or non-plenum rated HDPE piping in return air plenums.

3.4 PIPING INSTALLATIONS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration" and the equipment manufacturer's installation requirements.

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

C. Install piping for minimum number of joints using as few elbows and other fittings as possible.

D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

F. Insulate piping per Division 23 Section "HVAC Insulation."

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

G. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2 inch per 10 feet downward slope away from the compressor.
2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
4. Liquid lines may be installed level.

J. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

K. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

L. Pipe Protection for Flammable Refrigerants: Protect refrigerant piping used for A2L and B2L refrigerants located in concealed locations where tubing is installed in studs, joists, rafters or similar member spaces and located less than 1.5 inches from the nearest edge of the member. Piping shall be continuously protected by protective shield plates having a minimum thickness of 0.0575 in (No. 16 gage) and shall cover the area of the tube and shall extend a minimum of 2.0 inches beyond the outside edge of the tube.

3.5 HANGERS AND SUPPORTS

A. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Provide insulation saddles and protection shields as specified in Section "Hangers & Supports for HVAC Piping & Equipment". Provide insulation inserts as specified in Section "HVAC Insulation".

C. Install hangers with the following minimum rod sizes and maximum spacing:

NOM. PIPE SIZE	MAX. SPAN-FT	MIN. ROD SIZE – INCHES
Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
4	12	1/2
6	14	5/8

D. Support vertical runs at each floor. Support riser piping independently of connected horizontal piping.

E. Install a support within one foot of each change of direction.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Vibration Isolation:

1. Resiliently support piping within 50 feet of connected rotating equipment that has scheduled capacity greater than 50 tons of cooling.

a. Suspend pipe using Type SPNM or Type SPNH isolators. Provide vibration isolation anchors and guides for pipe. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to 1.5 times that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 1 inch.

b. Reference section "Vibration Isolation for HVAC Piping and Equipment" for isolator definition.

3.6 PIPE JOINT CONSTRUCTION

A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.

3.7 VALVE AND PIPING SPECIALTIES INSTALLATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

C. Install a full sized, 3-valve bypass around each drier.

D. Install solenoid valves ahead of each expansion valve . Install solenoid valves in horizontal lines with coil at the top.

1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.

E. Install electronic expansion valves where specified by the manufacturer. Provide isolation valves on each side of the valve for service purposes.

F. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

G. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

1. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.

I. Install flexible connectors at the inlet and discharge connection of compressors.

3.8 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow servicing and maintenance.

3.9 FIELD QUALITY CONTROL

A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5. Provide test report summarizing the test procedures and results of the tests.

B. Repair leaking joints using new materials, and retest for leaks.

C. Field Test: Every refrigerant-containing part of every system that is erected on the premises, except safety devices, pressure gauges, control mechanisms, compressors, evaporators, and systems that are factory-tested, shall be tested and proved tight after complete installation and before operation. The high side and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high side and low side of the system, respectively.

D. Testing Procedure: Tests shall be performed with dry nitrogen. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gage on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system's components.

3.10 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:

1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.11 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems in accordance with requirements of Division 23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.12 STARTUP

A. Charge system using the following procedure:
1. Install core in filter dryer after leak test but before evacuation.
2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 01 section "Closeout Procedures."

D. Schedule training with Owner through the Architect, with at least 7 days advance notice.

END OF SECTION

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

B. Duct liner.

C. Duct sealants.

D. Duct hangers and supports.

E. Wire rope hanging system.

F. Manufactured ductwork and fittings.

1.2 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.

2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.4 SUBMITTALS

A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Duct Liner.

2. Sealing Materials.

3. Fire-Stopping Materials.

B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.

2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.

3. Fittings.

4. Reinforcing details and spacing.

5. Seam and joint construction details.

6. Penetrations through fire-rated and other partitions.

7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.

8. Locations of fire and fire/smoke dampers and associated duct access doors.

9. Locations of cleanout and access doors in grease exhaust ducts.

10. Location of manual balancing dampers.

11. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.

12. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:

1. Coordination with ceiling suspension members.

2. Spatial coordination with other systems installed in the same space with the duct systems.

3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.

4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

D. Leak test report for ducts specified to be leak tested in Part 3. Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

E. Leak Test certificate for all smoke control duct joints and fittings in compliance with the locally adopted IMC.

F. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.

G. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

D. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

E. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

2. NFPA 90B, “Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

F. Sheet Metal and Air Conditioning Contractors’ National Association, Inc. (SMACNA): Provide ductwork systems in conformance with “HVAC Duct Construction Standards – Metal and Flexible,” latest edition.

G. Underwriter’s Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.

H. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

1.6 PROTECTION AND REPLACEMENT

A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.

B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

1.7 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS AND MATERIALS

2.1 DUCT ASSEMBLIES

A. Ducts: Galvanized steel, unless otherwise indicated. Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.

B. Supply Air Ducts (constant volume or single zone VAV systems): 3 inches w.g pressure class, galvanized steel.

C. Return and Relief: 2 inch w.g. pressure class, galvanized steel.

D. General Exhaust: 2 inch w.g. pressure class, galvanized steel.

E. Wet Area Exhaust Ducts, where noted on the drawings:

1. Type 304, stainless steel, minimum 24 gauge. Provide continuously welded seams on top or sides of duct and flanged joints with watertight EPDM gaskets.

2. Aluminum, minimum 24 gauge, with longitudinal seams and laps arranged on top of duct. Seal joints with silicone sealant to provide watertight joint.

F. Duct Liner Application: Provide duct liner on the following air ducts and where specified on the drawings.

1. Supply Ductwork:

a. All interior ductwork.

b. Exposed rectangular ductwork.

2. Return/Exhaust Ductwork.

a. First 15 feet of ductwork upstream of equipment outlets including exterior ductwork. Refer to Section “HVAC Insulation” for additional insulation requirements for exterior ductwork.

2.2 MATERIALS

A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.

B. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating.. Provide mill phosphatized or galvanized finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.

C. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength, with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.

D. Stainless Steel for Ducts: ASTM A 480, Type 316, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No. 1 finish for concealed ducts.

E. Duct Liner

1. General:

a. Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.

b. Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 or UL 723.

c. Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.

2. Fiberglass: ASTM C1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.

a. Rectangular fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.

1) Thickness and Density:

a) 1 inch, 1-1/2 pounds per cubic foot.

b. Round fiberglass duct liner shall be Certainteed ToughGard UltraRound, JohnsManville Spiracoustic Plus, Owens Corning QuietZone Spiral, or approved equal.

1) Thickness and Density:

a) 1 inch, 4 pound per cubic foot.

c. Thermal Performance: Meet minimum "K-Factor" equal to 0.28 (Btu·in/h·sq ft·F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.

d. Noise Reduction Coefficient (NRC): Meet the following minimum NRC in accordance with ASTM C423 Type A Mounting:

1) 1 Inch Thick: NRC 0.65.

e. Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 35% solid content, water-based, non-oxidizing and have a service temperature of –20 to 200 F. Water-based adhesive shall be one of the following:

1) Design Polymerics DP 2502.

2) Duro Dyne WIT.

3) Foster 85-60.

4) Childers CP-127.

5) Johns Manville SuperSeal.

6) Hardcast Coil-Tack.

f. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.

1) Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.

2) Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

3. Flexible Elastomeric Duct Liner: Insulation material shall be a flexible, closed cell, elastomeric insulation in sheet form that complies with ASTM C534. Material shall have a maximum thermal conductivity of 0.27 Btu-in/h-sf-F and a minimum water vapor transmission of 0.08 perm-inches. Liner shall be 1 inch thick or greater to meet local code requirements.

a. Manufacturers:

1) Aeroflex USA, Inc Aerocel Sheet.

2) Armacell LLC, AP Armaflex SA or Amaflex Ultra.

3) K-Flex USA Liner Gray.

4. Flexible Elastomeric Acoustical and Conformable Duct Liner: Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90B, Thickness: 1/2 inch and 1 inch, Thermal Conductivity: 0.25 BTU-in/hr sq ft F at 75 F mean temp, ASTM C 518, Noise Reduction Coefficient: 0.6, ASTM C 423, Sound Transmission Class (STC) 25, ASTM E 90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.

a. Manufacturers:

1) Aeroflex USA, Inc PLUS Acoustical Duct Liner.

2) Armacell LLC, AP Coilflex.

3) Approved equal.

5. Flexible Elastomeric Round or Spiral Duct Liner: Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90 B, Thickness: 1 inch, Thermal Conductivity: 0.28 Btu-in/hr sq ft F at 75 F mean temp, ASTM C 518 Noise Reduction Coefficient: 0.4, ASTM C 423 Sound Transmission Class (STC) 31, ASTM E90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.

a. Manufacturers:

1) Armacell LLC, AP Spiraflex.

2) Approved equal.

6. Polyester Duct Liner: Duct liner shall be an engineered nonwoven, thermally bonded polyester with a smooth and durable FSK facing. Liner shall have a noise reduction coefficient of at least 0.65 per ASTM C423 and have thermal values greater or equal to an R-5 at 1 inch, R-6 at 1-1/2 inch and R-8 at 2 inch, respectively. Polyester liner must be able to withstand a constant internal temperature up to 250 F, must be compliant with Greenguard Environmental Institute, and contain zero VOCs per ASTM D5116. Liner must comply with NFPA 90A, NFPA 90 B and UL 181. Liner must meet ASTM C518 for thermal conductance properties and ASTM G-21 for fungal resistance properties. Liner must consist of at least 25 percent recycled content.

a. Manufacturers:

1) Ductmate Industries “PolyArmor.”

2) Approved equal.

F. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.

2. Surface Burning Characteristics: Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.

3. For Use with Flexible Ducts: UL labeled.

4. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics. Duct tape shall not be used as a sealant on any ducts.

5. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.

6. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

7. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 65 percent solids. Approved products: Design Polymerics DP 1090, Duro Dyne SGD, Fosters 32-14, or approved equal.

8. Water-Based Joint and Seam Sealant: Non-Fibrated, UL 181 listed, rated to minimum SMACNA Pressure Class of ±10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymerics DP 1010, Ductmate Proseal, Duro Dyne Duroseal EDS-RS, Fosters 32-18, Hardcast Iron-Grip 601, Red Devil D-Seal and United McGill United Duct Seal WB.

9. Water-Based Joint and Seam Sealant: Fiber reinforced, UL 181 listed, rated to minimum SMACNA Pressure Class of ±10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymerics DP 1030, Ductmate Fiberseal, Duro Dyne Duroseal EDS-RF, Fosters 32-17, Hardcast CCWI-181, Red Devil F-Seal 181 or United McGill Uni-Mastic.

10. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

11. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of –25 to 180 F. Approved Products: Design Polymerics DP 1040, Ductmate 440, and Hardcast 1104.

G. Fire Stopping

1. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

2. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

3. Products: Subject to compliance with requirements, provide one of the following:

   a. "3M Fire Stop Foam"; 3M Corp.

   b. "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.

   c. 3M Fire Stop Sealant"; 3M Corp.

   d. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.

   e. "Fyre Putty"; Standard Oil Engineered Materials Co.

   f. “FS-ONE”, Hilti, Inc.

H. Hangers and Supports

1. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

   a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.

   b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.

   c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

   d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.

   e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

3. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.

4. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.

   a. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

   b. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.

5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

6. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

   a. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.

   b. For stainless steel ducts, provide stainless steel support materials.

   c. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

7. Wire Rope Hanging Systems:

   a. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

   b. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.

   c. Wire Rope: Zinc coated or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

   d. Cable Lock: Cast zinc housing with steel spring with wedge grip, selected to meet the vertical load applied to the hanging system and wire thread. Do not exceed the working load limit.

   e. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

   f. Seismic Applications: Wire rope hanger systems used for seismic supports shall be seismically tested according to ICC code guidelines EG284 with UL and SMACNA seismic approvals. Reference Division 23 Section "Seismic Controls for Mechanical Systems" for additional requirements.

   g. Manufacturers:

      1) ASC Engineered Solutions.

      2) Ductmate Industries, Inc; Clutcher Cable Hanging System.

      3) Duro Dyne.

      4) Gripple.

I. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

J. Tie Rods: Same material as the duct, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 DUCTWORK FABRICATION

A. Fabricate and support duct in accordance with latest edition of SMACNA (DCS).

B. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

   1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.

   2. Fabricate ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.

E. Exterior Ductwork: Ductwork installed exterior to the building without weather-proof jacket or cladding shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph “Seam and Joint Sealing”.

1. Lined Ductwork: Where exterior ductwork is specified on the drawings to be provided with interior lining for thermal or sound performance requirements, seal the longitudinal and transverse joints with sealant rated for exterior exposure.

F. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.

G. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.

H. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

I. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer’s approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section “Ductwork Accessories” for turning vane construction and mounting.

J. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

K. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

L. Round and Flat Oval Duct Fabrication

1. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.

a. Fabricate round and flat oval ductwork of minimum 26 gauge sheet metal.

M. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.

N. Flat Oval Ducts: Fabricate flat oval supply ducts with standard spiral lockseams (without intermediate ribs) or with butt-welded longitudinal seams in gauges listed in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-15.

O. Round and Flat Oval Fittings Fabrication

1. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.

2. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

3. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:

   a. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.

      1) Elbows in Round Duct: Provide full radius elbows.

      2) Elbows in Flat Oval Duct: Provide full radius elbows. Where space limits the installation of full radius elbows, short radius elbows with a minimum of two continuous splitter vanes shall be installed. Vane length shall be the entire length of the bend or 36 inches whichever is greater.

      3) The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

      4) Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section “Basic Mechanical Materials and Methods” for noise critical spaces.

   b. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.

      1) Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.

      2) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

         a) 3 to 26 inches: 24 gauge.

         b) 27 to 36 inches: 22 gauge.

c) 37 to 50 inches: 20 gauge.

d) 52 to 60 inches: 18 gauge.

e) 62 to 84 inches: 16 gauge.

3) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

a) 3 to 14 inches: 24 gauge.

b) 15 to 26 inches: 22 gauge.

c) 27 to 50 inches: 20 gauge.

d) 52 to 60 inches: 18 gauge.

e) 62 to 84 inches: 16 gauge.

4) Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.

5) 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.

c. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

d. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

e. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

f. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.

g. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.

h. Flat Oval Elbows Gauges: Same as longitudinal seam flat oval duct.

i. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.

j. Insulation: Unless otherwise indicated, provide 1-inch-thick. 1.5 pounds per cubic foot density fiber-glass insulation with thermal conductivity performance of 0.27 Btu/sq.ft./°F/inch-thickness at 75°F mean temperature. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.

k. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gauges listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."

l. Perforated Inner Liner: Construct round and flat oval inner liners with perforated sheet metal of the gauges listed below. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."

1) 3 to 34 inches: 24 gauge.

2) 35 to 58 inches: 22 gauge.

3) 60 to 88 inches: 20 gauge.

m. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

4. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

a. Round Elbows 4 to 8 Inches: 2-piece, die stamped, with longitudinal seams spot welded, bonded, and painted with a PVC aerosol spray.

b. Round Elbows 9 to 26 Inches: Standing seam construction.

c. Round Elbows 28 to 60 Inches: Standard gore construction, riveted and bonded.

d. Other Fittings: Riveted and bonded joints.

e. Couplings: Slip-joint construction with a minimum of a 2-inch insertion length.

P. Shop Application of Liner in Rectangular Ducts

1. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

2. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

3. Butt transverse joints without gaps and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

5. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

a. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.

6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

7. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

a. Fan discharge.

b. Intervals of lined duct preceding unlined duct.

c. Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.

8. Secure insulation liner with perforated sheet metal liner of the same gauge specified for the duct, secured to ducts with mechanical fasteners that maintain metal liner distance from duct without compressing insulation. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent.

9. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

A. General: At the Contractor's option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer. The oval duct system shall be sealed with duct sealer as specified.

1. Ducts shall be calibrated to manufacturer's published dimensional tolerance standard.

2. All duct 14" diameter and larger shall be corrugated for added strength and rigidity.

3. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.

4. Ducts shall be constructed using spiral lock seam sheet metal construction.

5. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

B. Duct Construction

1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10" water gauge pressure with minimum wall thickness as shown in the following tables.

2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.

3. Ducts shall be constructed using spiral lock seam sheet metal construction.

4. Ductwork to be installed in exposed locations shall be factory-prepared for field painting, i.e. mill-phosphatized.

Single Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)
3-14	28	24
15-24	26	24
26-42	24	22
42-60	22	20

Oval Duct:

Major Axis (Inches)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)

3-24	24	20
25-38	22	20
37-48	22	18
49-60	20	18
61-70	20	16
71 and large	18	16

C. Fittings:

1. All fitting ends for round duct and transitions and divided flow fittings smaller than 24” diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.
3. All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.
4. All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.
5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be minimum 1.0 times the elbow diameter.
6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.
7. All volume dampers shall be Linx Safe type DRU, DSU or DTU or equal by an acceptable manufacturer. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:
    a. Locking quadrant with blade position indicator.
    b. 2" sheet metal insulation stand-off.
    c. Integral shaft/blade assembly.
    d. Shaft mounted, load bearing bushings.
    e. Gasketed shaft penetrations to minimize leakage.

D. Manufacturers:

1. Hercules Industries.
2. Hranec Corporation.
3. Lewis & Lambert.
4. Linx Industries, Inc.
5. Semco.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products in accordance with manufacturer's instructions.

C. Install ducts with the fewest possible joints.

D. Seal duct joints with the appropriate sealing material.

E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

J. Install insulated ducts with 1-inch clearance outside of insulation.

K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

M. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.

N. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

O. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

P. Acoustical Barrier Penetrations: Where a duct passes through a wall, ceiling or floor slab of a noise critical space, provide a clear annular space of 1-inch between the duct and the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces.

The Contractor shall check the clearance and, if clearance is acceptable, shall install the duct and pack the voids full depth with mineral fiber batt insulation. Contractor shall caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material. Where there is insufficient clearance space, Contractor shall place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

Q. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.

R. Duct Liner Installation

1. Fiberglass Duct Liner:

a. Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.

2. Flexible Elastomeric Duct Liner:

a. Install liner in accordance with the manufacturer's installation instructions or ASTM C 1710.

b. Attach flexible elastomeric duct liner to clean, oil-free sheet metal surfaces with adhesive as recommended by the liner manufacturer.

c. Seal all longitudinal seams and end joints with manufacturer's recommended adhesive and install compression joints in accordance with manufacturer's instructions to eliminate any openings in insulation that would allow passage of air to duct surface being insulated.

3. Polyester Duct Liner:

a. Install polyester duct liner per SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible," unless otherwise specified.

b. Attach polyester duct liner using a nonflammable, low VOC water based adhesive.

c. Apply a nonflammable, low VOC water based lagging adhesive to the exposed leading edge of the insulation.

d. Install fasteners per SMACNA HVAC Duct Liner installation instructions.

S. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

T. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

U. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

V. Seam and Joint Sealing

1. General: Seal duct seams and joints as follows:

a. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.

b. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized. Transfer air ducts and sound boots do not need to be sealed.

2. Seal externally insulated ducts prior to insulation installation.

3. Ductwork installed exterior to the building without weather-proof jacket or cladding shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

a. Lined Ductwork: Where exterior ductwork is specified on the drawings to be provided with interior lining for thermal or sound performance requirements, seal the longitudinal and transverse joints with sealant rated for exterior exposure.

W. Hanging and Supporting

1. Install rigid round, rectangular, and flat oval metal duct with support systems per SMACNA standards.

2. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer’s instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer’s recommended load rating.

a. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.

3. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

4. Support vertical ducts at a maximum interval of 16 feet and at each floor.

5. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.

6. Install concrete insert prior to placing concrete.

7. Install powder actuated concrete fasteners after concrete is placed and completely cured.

8. Provide double nuts and lock washers on threaded rod supports.

9. 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.

10. Refer to Section “Seismic Controls for Mechanical” for seismic bracing requirements.

X. Penetrations

1. Fire Barrier Penetrations: Where ducts pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

2. Exterior Wall Penetrations: Seal duct penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

3. Underground Exterior Wall Penetrations: Seal duct penetrations through underground exterior walls with sleeves, packing, and sealant. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

4. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Piping Materials and Methods” for special sealers and materials.

Y. Connections

1. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."

2. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards”.

3. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards". Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."

4. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards”.

3.2 FIELD QUALITY CONTROL

A. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

B. General Duct Systems: Perform leakage tests on the duct systems listed below in accordance with ASHRAE and SMACNA standards.

1. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

2. Conduct tests at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure. Give 7 days' advanced notice for testing. Submit a letter report to the Owner and Engineer summarizing the test procedures followed, systems tested and the results of the leakage tests.

3. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.

4. Maximum Allowable Leakage: As described in ASHRAE 2005 Handbook, "Fundamentals" Volume, Chapter 35, Table 9 and Figure 13. Comply with requirements for leakage classification 3 for round and flat oval ducts, leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gauge (both positive and negative pressures), and leakage classification 6 for pressure classifications greater than 2 inches water gauge and less than and equal to 10 inches water gauge.

5. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

6. Leakage Test: Perform volumetric measurements and adjust air systems as described in Testing, Adjusting and Balancing chapter of ASHRAE "HVAC Applications" Volume, Duct Design chapter of ASHRAE "Fundamentals" Volume, and Division 23 Section "Testing, Adjusting and Balancing for HVAC."

C. Ductwork with Pressure Rating > 3" W.C.: Ducts and plenums shall be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual to prove they meet leakage classification less than or equal to 6. Submit test reports to the Engineer of Record demonstrating that at least 25 percent of the installed duct area has been tested and pass this test.

3.3 ADJUSTING, STARTUP AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "Testing, Adjusting and Balancing for HVAC" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum duct systems prior to final acceptance to remove dust and debris.

C. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.

D. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.

1. Refer to Division 23 Section "Particulate Air Filtration" for filter requirements.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Turning vanes.

B. Backdraft dampers.

C. Combination fire and smoke dampers.

D. Duct access doors.

E. Duct hardware.

F. Flexible duct connectors.

G. Volume control dampers.

H. Duct opening closure film.

I. Cable operated damper systems.

J. Flexible ductwork.

K. Flexible elbow assembly.

1.2 SUBMITTALS

A. Product Data: Provide for each type of ductwork accessory the following:

1. Electrical characteristics.
2. Connection requirements.
3. Dimensions.
4. Capacities.
5. Pressure drops,
6. Leakage rates.
7. Materials of construction.

B. Shop Drawings: Indicate for shop fabricated assemblies the following:

1. Interfacing requirements with ductwork.
2. Method of fastening or support.
3. Methods of assembly of components.

C. Performance Data: Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.

D. Project Record Drawings: Record actual locations of access doors and test holes.

E. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. SMACNA Compliance: Comply with applicable portions of SMACNA (DCS) “HVAC Duct Construction Standards Metal and Flexible”.

C. UL Compliance:

1. Fire Dampers: Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 Standard for Fire Dampers.

2. Smoke Dampers: Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S Standard for Smoke Dampers.

3. Flexible Ductwork: Construct flexible ductwork in compliance with UL Standard 181 Factory-Made Air Ducts and Connections.

4. Duct Tape: Label in accordance with UL Standard 181B and marked 181B-FX.

5. Duct Clamps: Label in accordance with UL Standard 181B and marked 181B-C.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated

E. NFPA Compliance:

1. Comply with applicable provisions of NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems and NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems pertaining to installation of ductwork accessories.

2. Comply with NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for fire-rated grease exhaust ducts.

F. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 “Standard Test Method for Surface Burning Characteristics of Building Materials” (NFPA 255) method.

1. Duct silencers shall be tested for performance in accordance with ASTM E477 “Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.”

2. Grease exhaust duct wrap shall be tested for performance in accordance with ASTM E 2336 “Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems” and ASTM E814 “Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops”.

3. Fire rated duct wrap shall be tested in accordance with ASTM E814 “Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops”.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork accessories during shipping and storage from dirt, debris and moisture damage.

B. Protect dampers from damage to operating linkages and blades.

1.5 SPARE PARTS

A. Extra Fusible Links: One link for every 10 installed of each type, size and temperature range. Obtain receipt.

PART 2 - PRODUCTS

2.1 TURNING VANES

A. Manufacturer:

1. Aero Dyne Co.
2. Anemostat Products Div.; Dynamics Corp. of America.
3. Ductmate Industries.
4. Duro Dyne Corp.
5. Elgen Manufacturing Co., Inc.
6. Hart & Cooley Mfg. Co.
7. Register & Grille Mfg. Co., Inc
8. Sheet Metal Connectors, Inc.

B. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed.

1. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration.
2. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened.
3. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

C. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section “Common Work Results for HVAC” for noise critical spaces.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Cesco Products.

3. Greenheck
4. Louvers & Dampers, Inc.
5. Nailor Industries, Inc.
6. Pottorff
7. Prefco Products, Inc.
8. Ruskin Mfg. Co.

B. General: Provide combination fire and smoke dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire and/or smoke ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire and smoke damper and fusible link as required. Provide sleeves of length as required to meet the installed location. Damper assemblies shall be provided as a single unit from the manufacturer.

C. Fabricate dampers in accordance with NFPA 90A, UL555 (current edition) classified fire damper of rating required for location installed, UL555S (current edition) classified smoke damper for leakage class II and rated for dual directional airflow.

D. Fire/smoke dampers shall be rated for closure in ducts up to minimum velocity of 2,000 fpm and static pressure of 4" w.g.

E. Multiple Blade Dampers:

1. Frame: Minimum 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.
2. Blades: Minimum 22 gauge thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2,000 fpm.
3. Bearings: Self-lubricating, turning in extruded hole in the frame.
4. Linkage: Plated steel axles, linkage concealed in frame, 1/2" actuator shaft.
5. Seals: Flexible, stainless steel jamb seals, silicone rubber blade seals with galvanized steel mechanical locked in to the blade edge and stainless steel spring loaded leakage seals in sides of casing. Provide stainless steel spring loaded leakage seals in sides of casing, and the following additional features:
    a. Open-closed indication switch.
    b. Temperature Limited Override.
    c. Test Switch.
    d. Smoke Detector.

F. Operators:

1. UL listed and labeled.
2. Spring return open/fail closed operation.
3. Two-position or modulating as required for the installation.
4. Electric type suitable for 120 Volts, single phase, 60 Hz.
5. Factory installed on dampers.

6. All operators shall open in between 7 and 15 seconds and close in between 7 and 15 seconds after alarm or smoke detection has occurred.

7. Rated for a minimum of 20,000 cycles of operation.

8. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.

G. Electro Thermal Link: Provide resettable temperature device rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated.

H. Smoke Activation:

1. Provide terminal block for connection to the building fire alarm system.

I. Accessories:

a. Open-closed indication switch.

b. Temperature Limited Override.

c. Test Switch.

d. Smoke Detector.

e. Integral end switch.

2.3 DUCT ACCESS DOORS

A. Manufacturers:

1. Air Balance Inc.

2. Ductmate Industries.

3. Duro Dyne Corp.

4. Greenheck.

5. Register & Grille Mfg. Co., Inc.

6. Ruskin Mfg. Co.

7. Ventifabrics, Inc.

8. Vent Products.

9. Zurn Industries, Inc.; Air Systems Div.

B. Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10” by 10” and maximum size of 24” by 24”. Fabricate in accordance with SMACNA (DCS) and as indicated. Label access doors for fire and smoke dampers as specified in Part 3.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. Construct of same or greater gauge as ductwork served. For insulated ductwork. install minimum 1 inch thick insulation with sheet metal cover. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct.

1. 12 inches square or less: Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Provide

removable section of duct where duct size is too small for a 10” by 10” access door.

2. Larger than 12 inches square: Provide two hinges and two handle-type latches.

2.4 DUCT HARDWARE

A. Manufacturers:

1. Ductmate Industries.
2. Elgen Manufacturing Co., Inc.
3. Ventfabrics, Inc.
4. Young Regulator Co.

B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated.

1. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
2. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.5 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:

1. Carlisle HVAC Products.
2. Ductmate Industries.
3. Duro Dyne Corp.
4. Elgen Manufacturing Co., Inc.
5. Ventfabrics, Inc.

B. Fabricate in accordance with SMACNA (DCS) and as indicated. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

C. Flexible Duct Connections: Fabric crimped into metal edging strip. Provide metal compatible with connected ducts. Factory fabricated. Flame-retardant or noncombustible fabrics compliant with NFPA 701.

1. High-Temperature Fabric: UL listed fire-retardant glass fabric coated with silicone rubber.
    a. Minimum Weight: 16 oz./sq. yd.
    b. Minimum Tensile Strength: 200 lbf/inch in the warp and 150 lbf/inch in the filling.
    c. Service Temperature: Minus 65 to plus 500 deg F.

2. Metal: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum.

D. Maximum Installed Length: 14 inch.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

2.6 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Arrow United Industries
3. Cesco
4. Greenheck
5. Louvers & Dampers, Inc.
6. Nailor Industries, Inc.
7. Pottorff
8. Rossi Air Flow
9. Ruskin Mfg. Co.
10. TAMCO
11. Vent Products

B. Fabricate dampers in accordance with SMACNA (DCS) and as indicated. Construct using galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.

C. Single Blade Dampers:

1. Fabricate for duct sizes up to 12 x 36 inch.
2. Blade: 20 gauge, 0.04 inch, minimum.

D. Multi-Blade Damper: Fabricate of parallel or opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

1. Blade: 18 gauge, 0.0478 inch, minimum.

E. Bearings: Corrosion resistant, molded synthetic.

F. Axles: Positively lock into the damper blade.

G. Blade Seals: Where used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.

H. Quadrants:.

1. Provide locking, indicating quadrant regulators.
2. On insulated ducts, provide extended shafts and mount regulator on standoff bracket, base or adapter.

3. Where rod lengths exceed 48 inches, provide regulator at both ends.

2.7 DUCT OPENING CLOSURE FILM

A. Mold-resistant, self-adhesive film to keep debris out of ducts during construction.

B. Thickness: 2 mils.

C. High tack water-based adhesive.

D. UV stable.

E. Elongation Before Break: 325 percent, minimum.

2.8 CABLE OPERATED DAMPER SYSTEMS

A. Manufacturer:

1. DuroDyne, DuroZone.
2. Metropolitan Air Technology, Inc. (Reference model number for round damper is RT-250 and for rectangular damper is RT-200).
3. Young Regulator Co. (Reference model number is 270).

B. General: Where access to dampers through a hard ceiling is required, provide a concealed, remote cable-operated, butterfly-type volume damper assembly with external worm gear operator.

C. Damper assembly shall include duct casing with rolled bead stiffeners, reinforced blade, self-lubricating bearing, and remote operator mounting plate.

D. Adjustable through the diffuser frame with standard 1/4 inch nut-driver or flat screwdriver.

E. Cable assembly shall attach to damper as a single piece with no linkage adjustment required.

F. Positive, direct, two-way damper control with no sleeves, springs or screw adjustments to come loose after installation.

G. Cable length as required to span the distance from the damper to the remote operator location.

H. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

2.9 FLEXIBLE DUCTWORK

A. Manufacturers:

1. ATCO Rubber Products.
2. Flexmaster.
3. JPL (J.P. Lamborn Co)
4. Thermaflex.

B. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regard to required quality of construction and materials.

C. Insulated Flexible Ductwork: Provide duct fabric of ply-vinyl film, polyethylene film or multiple layers of aluminum laminate supported by helically wound spring steel wire. Wrap fabric with fiberglass insulation and provide fire retardant polyethylene or reinforced metalized protective vapor barrier as specified herein.

1. Duct pressure class up to and including 6" w.g.
    a. Fire retardant polyethylene vapor barrier
        1) ATCO 80 Series
        2) Flexmaster Type 5B
        3) JPL Type PR Series
        4) Thermaflex Type G-KM
    b. Reinforced metalized vapor barrier
        1) ATCO 30 Series
        2) Flexmaster Type 5M
        3) JPL Type MHP Series
        4) Thermaflex Type M-KE
2. High pressure (duct pressure class over 6" w.g.)
    a. Fire retardant polyethylene vapor barrier
        1) Flexmaster Type 3B
    b. Reinforced metalized vapor barrier
        1) ATCO OmniAir 1200
        2) JPL Type FHP-25
        3) Flexmaster Type 3M
        4) Thermaflex Type M-KC
3. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
4. Provide acoustical, fiberglass insulated duct with minimum R-value of R-6.0.

D. Uninsulated Flexible Ductwork: Provide duct fabric of triple ply materials supported by helically wound spring steel wire.

1. Pressure Rating: 10 inches w.g. positive and 1.0 inches w.g. negative.
2. Maximum Velocity: 4,000 fpm.
3. Manufacturer:
    a. ATCO 050 Series
    b. Flexmaster 5NI-C
    c. JPL Type MNI
    d. Thermaflex S-LD

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Provide vanes in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease or dryer exhaust ductwork.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Provide combination fire and smoke dampers, fire dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction.

1. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
2. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.
3. Install ceiling radiation dampers per manufacturer’s instructions. Support damper assembly from structure.
4. Demonstrate re-setting of fire and fire/smoke dampers to Owner's representative.

E. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

1. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1” lettering) indicating which damper type is served. Door shall be capable of being fully opened or provide removable door.

DUCT ACCESS DOOR SCHEDULE

Duct Width/Depth	Door Size	Quantity
10" TO 12"	10 X 10	1
14" TO 18"	12 X 12	1
20" TO 36"	14 X 14	1
38" TO 54"	18 X 18	1
56" TO 72"	18 X 18	2 (1 EACH END)
74" TO 96"	20 X 20	2 (1 EACH END)

2. As an alternate to duct access door for fire damper access in ducts 12 inch and smaller in each direction, a removable duct section can be provided. The duct section shall be Langdon Inc. "Sure Clamp Access" or approved equal with the following features:

   a. Be removable without use of tools.

   b. Be within 4 inches of the damper sleeve break away connection.,

   c. Be insulated same as connected ductwork.

   d. Have same pressure rating as the duct.

   e. Have gaskets at seams to seal the connections.

3. Provide duct access doors for cleaning kitchen exhaust ducts in accordance with NFPA 96. Review locations prior to fabrication.

F. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.

1. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

2. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

G. Provide volume control dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual volume control damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.

H. Install constant airflow regulators square and free from racking. Do not compress or stretch damper frame into duct or opening. Handle damper using frame or sleeve.

I. Provide cable operated volume dampers with remote operators where access to dampers through a hard ceiling is required.

1. Support cable assembly to avoid bends and kinks in cable.

J. Install acoustical plenums in accordance with manufacturer's written instructions. Support acoustical plenums from the floor or above structure as required for the location shown on the drawings.

K. Install flexible ductwork in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.

1. Flexible ductwork runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.

2. Install flexible ductwork straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible ductwork fully extended minimizing compression.

3. Provide continuous length with no intermediate joints.

4. Support flexible ductwork from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.

5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.

6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.

   a. Factory installed suspension systems are acceptable

7. Do not crimp flexible ductwork against joist or truss members, pipes, conduits, etc.

8. Install flexible ductwork with bend radius at the center line equal to or greater than one duct diameter.

   a. Support bends approximately one duct diameter on both sides of bends.

9. Connect flexible ductwork to sheet metal ductwork and air devices with at least 1" overlap.

L. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.

M. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

B. After start-up, final corrections and balancing of systems, test duct silencers by taking octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed. Refer to Division 23 Section "Testing, Adjusting and Balancing of HVAC" for additional requirements.

1. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.

2. Submit complete report of test results including sound curves.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".

C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 233300

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ceiling air diffusers.

B. Registers and grilles.

C. Drop box diffusers.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details. Indicate selections on product data.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

D. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

E. Color Samples for Initial Selection: Manufacturer’s color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

1.3 QUALITY ASSURANCE

A. Test and rate air outlets and inlets in accordance with ASHRAE 70 “Method of Testing the Performance of Air Outlets and Inlets”.

B. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 “Certification, Rating and Test Manual”.

C. Provide air outlets and inlets bearing ADC Certified Rating Seal.

D. Test and rate sound data for air outlets and inlets in accordance with AHRI 885 “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets (with Addendum 1)”.

E. Install air outlets and inlets in accordance with NFPA 90A “Standard for the Installation of Air Conditioning and Ventilating Systems”.

F. Test and rate louvers in accordance with AMCA 500 “Test Method for Louvers, Dampers and Shutters”.

1.4 SPARE PARTS

A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS

2.1 CEILING AIR DIFFUSERS

A. Manufacturers

1. Carnes Co.
2. Greenheck.
3. Krueger Mfg. Co.
4. Metalaire; Metal Industries, Inc.
5. Nailor Industries, Inc.
6. Price Industries, Inc.
7. Titus HVAC
8. Tuttle & Bailey; Div. of Air Systems Components, Inc.

B. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

D. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

E. Types: Provide ceiling air diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.2 REGISTERS AND GRILLES

A. Manufacturers

1. Carnes Co.
2. Greenheck.

3. Krueger Mfg. Co.
4. Metalaire; Metal Industries, Inc.
5. Nailor Industries, Inc.
6. Price Industries, Inc.
7. Titus HVAC
8. Tuttle & Bailey; Div. of Air Systems Components, Inc.

B. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

D. Ceiling Compatibility: Provide registers and grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of register and grille.

E. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

F. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.3 DROP BOX DIFFUSERS

A. Manufacturers
1. AES Industries
2. Carnes Co.
3. EP Custom Products
4. Kees
5. Plenums Inc.
6. Price
7. Ruskin
8. **Curbs Plus**

B. General: Except as otherwise indicated, provide manufacturer's standard drop box diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

C. Performance: Provide drop box diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

D. Construction: Drop box diffusers shall be minimum 22 gauge galvanized steel construction, factory assembled and welded, and provided with standard duct connections and mounting brackets for field installation.

1. Diffusers shall have double deflection grilles or drum louvers that are individually adjustable to customize horizontal and vertical throws and factory installed air diverters or turning vanes.

2. Diffusers shall be insulated with 1” thick, 1.5 lb duct liner insulation.

E. Diffusers shall have be factory primed and painted, color as selected by the Architect.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.

C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 section “Air Duct Accessories”.

D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION 233713

SECTION 236423 - SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air cooled chiller.

B. Controls and control connections.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division I Specification Sections.

B. Product Data: Product data for each chiller, including chiller refrigerant, chiller capacity, minimum and maximum chilled water flows, weights (shipping, installed and operating), furnished accessories and electrical characteristics. Provide short circuit current rating of factory mounted starter or variable frequency drive.

C. Shop Drawings: Shop Drawings showing fabrication and installation of chillers, including plans, elevations, sections, details of components, attachments, and other construction elements. Include the following:

1. Dimensions.
2. Weight loadings and distribution.
3. Clearances for maintenance and operation.
4. Size and location of field connections.

D. Wiring Diagrams: Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

E. Manufacturer's Certificate: Certify that components furnished but not produced by manufacturer meet or exceed manufacturer's requirements.

F. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.

G. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

H. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

I. Operation & Maintenance Manuals: Operation and maintenance data to be included in Operation and Maintenance manuals. Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.

J. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Refrigerant: One container.

2. Extra Lubricating Oil: One container.

1.4 QUALITY ASSURANCE

A. AHRI Compliance: Rate chiller according to AHRI 550/590 “Standard for Water Chilling Packages using the Vapor Compression Cycle”.

B. ASHRAE Compliance: Conform to ASHRAE 15 “Safety Code for Mechanical Refrigeration” for chiller design, construction, leak testing and installation.

C. ASME Compliance: Where specified, fabricate and stamp chillers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. NEC Compliance: Comply with NFPA Standard 70 – National Electrical Code.

E. UL Compliance: Fabricate scroll chillers to comply with UL 1995 "Standard for Safety Heating and Cooling Equipment”.

F. Chiller manufacturing plant must be ISO 9001:2000 registered.

G. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.

H. Model furnished must have been in service for at least 2 years.

I. When required, provide certification of inspection for conformance to requirements of Authority Having Jurisdiction.

1.5 FLAMMABLE REFRIGERANTS

A. Equipment with refrigeration systems using Group A2L refrigerants shall meet all requirements of ASHRAE Std 15 and this section.

B. Listing and Installation Requirements:

1. Listed in accordance with UL 484 or UL 60335-2-40/CSA C22.2 No. 60335-2-40.

2. The nameplate shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing.

3. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing.

C. Refrigeration systems shall have an integral refrigerant detection system that meets the following requirements as documented in ASHRAE Std 15:

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.
2. Field recalibration of refrigerant detection system shall not be permitted.
3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.
4. Have access for replacement of refrigerant detection system components.
5. Have self-diagnostics to determine operational status of the sensing element.
6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.
7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, -1%).

D. Manufacturer's refrigeration mitigation action shall be completed in not more than 15 seconds after the initiation of the output signal of the equipment's integral refrigerant detection system and shall be maintained for at least 5 minutes after the output signal has reset.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting equipment.

B. Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil by the manufacturer, except condenserless which shall be charged at site in accordance with manufacturer's instructions. If refrigerant is shipped separately from chiller, chiller shall be charged with nitrogen.

1.7 WARRANTY

A. Manufacturer shall warrant all chiller equipment and material for a period of one year from equipment startup, or 18 months from date of shipment, whichever occurs first.

B. Manufacturer's Special Warranty on Compressor and Electric Motor: Written parts and labor warranty, signed by manufacturer agreeing to repair or replace compressor and/or compressor motor, including replacement of refrigerant for a period of 5 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carrier.

B. Dunham Bush.

C. Trane.

D. York.

2.2 CHILLER APPLICATIONS

A. Chiller

1. Packaged Air-Cooled Condenser.

2.3 CHILLERS

A. Chillers: Factory assemble and test chiller consisting of compressor(s), compressor motor(s), evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, starters, and microprocessor-based controls.

1. Rating: AHRI 550/590.
2. Safety: UL 1995 and ASHRAE Std 15.
3. Construction & Testing: ASME BPVC-VIII-1 as applicable for construction type.
4. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the Authority Having Jurisdiction.
5. Enclosures:
    a. Frame:
        1) Heavy-gauge steel.
        2) Factory apply hot-dipped galvanized or air-dried paint finish.
    b. Steel Chiller Cabinets:
        1) Factory apply baked on enamel or baked on powder paint finish.
        2) Perform 500-hour minimum salt spray test in accordance with ASTM B117.
    c. Electrical Equipment:
        1) NEMA 250 or UL 1995 as applicable.
        2) Power panels shall be NEMA Type 3 rain/dust tight.
        3) Painted steel cabinets with hinged, latched, lockable and gasketed outer doors. Provide main power connections, control power connections, compressor start contactors, current overloads and factory wiring.
        4) Power supply shall enter unit at a single location.
        5) Exposed wiring shall be routed through liquid tight conduit.
        6) For air-cooled chillers, evaporator heater shall have a separate power connection from the chiller power connection.
6. Motors: UL 984. See Section “Common Motor Requirements for HVAC Equipment” for additional requirements.
7. Chilled Water Flow Switch: Furnish field-mounted differential pressure sensor or thermal dispersion flow switch (paddle-type flow switch not allowed).

B. Chiller options

1. Air Cooled Chiller

    a. Chiller shall be provided with the following options:

        1) Low ambient control to meet temperature scheduled on the drawings.

        2) Factory mounted non-fused disconnect switch.

        3) Double-thickness evaporator insulation.

        4) Evaporator heater.

            a) Evaporator heater shall be sized to maintain 40°F water temperature with ambient temperature specified in the schedule on the drawings.

            b) Heater shall have separate electrical connection.

        5) Architectural Louvered Panels.

        6) Seismically Rated Unit.

2.4 COMPRESSORS AND EVAPORATOR

A. Compressors: Hermetic scroll type.

1. Unit: Fully hermetic type with single or multiple, direct drive compressors with service valves.

2. Vibration Control: Factory installed internal isolators or field installed external isolators.

3. Oil Lubrication System: Initial oil charge, oil sump, heater, oil level, and sight glass.

4. Capacity Reduction System: Compressor staging with control down to 12 percent of full load without the activation of hot gas by-bass.

5. Motor: 3600 rpm, suction gas-cooled, with thermal or current overload protection on all three phases. open drip-proof, continuous duty, squirrel cage, induction-type motor. Motors operated by variable frequency drives shall be inverter-duty rated and shall have shaft grounding system as specified in Section “Common Motor Requirements for HVAC Equipment”

B. Evaporator: Provide shell and tube on factory-assembled skid for remote mounting

1. Shell and tube type.

    a. Shell, removable heads and tube support sheets constructed of carbon steel.

    b. Tubes: Mechanically expand and fasten, seamless, externally or internally enhanced, copper tubes into intermediate tube support sheets along the length of shell to avoid contact and relative motion between tubes.

    c. Refrigerant Working-Side Pressure Rating: ASME rated for 400 psig minimum.

    d. Water Working-Side Pressure Rating: ASME rated for 150 psig minimum.

e. Provide with flanged, grooved, or threaded connections.

f. Insulation for all cold surfaces.

1) Insulation shall be factory or field installed.

2) 0.75 inches minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, vinyl nitrate polymer or flexible elastomeric insulation with a maximum k value of 0.28.

g. Provide factory or field installed vents and water drain connections on evaporator or piping.

h. Provide factory or field installed fittings for temperature control sensors on evaporator or piping.

i. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures specified in the schedule on the drawings.

2.5 AIR-COOLED CONDENSER AND FANS

A. Provide finned-tube, brazed one-piece, or flat tube-plate-manifold type.

1. Finned-tube type.

a. Mechanically bond aluminum fins to copper tubing and protect with corrosion resistant materials or coatings.

b. Clean, dehydrate and test.

c. Leak Test: 650 psig minimum.

2. Brazed one-piece type.

a. Construct of same material to avoid galvanic corrosion.

b. Braze coils and headers as one assembly.

c. Clean, dehydrate and test.

d. Leak Test: 650 psig minimum.

3. Flat tube-plate-manifold type.

a. Construct all components of same aluminum alloy to avoid galvanic corrosion.

b. Braze manifolds, flat tubes and fin-plates together to form single coil assembly.

c. Clean, dehydrate and test.

d. Leak Test: 650 psig minimum.

B. Coil Guards: Provide corrosion proof, louvered panels, heavy gage wire panels, or grilles factory installed. Provide coil protection for shipping by enclosing entire condenser coil with heavy plastic to prevent coil damage during shipping or rigging.

C. Fans and Motors:

1. Fans: Dynamically balanced propeller, shrouded-axial, or airfoil type fans of reinforced polymer, glass fiber reinforced composite, or aluminum corrosion resistant construction equipped with sealed, permanently lubricated ball bearings.
2. Discharge Fan Guards: Corrosion resistant, heavy gage, steel wire.
3. Discharge Direction: Vertical.
4. Motors: Direct drive, totally enclosed for outdoor use with current overload protection.

2.6 REFRIGERATION CIRCUITS

A. Provide multiple independent refrigeration circuit(s) with one or multiple compressor(s) per circuit to match the required staging capacity.

B. Provide liquid line shut-off valve, filter-drier, expansion valve, refrigerant relief device, solenoid valve, sight glass with moisture indicator, closed cell foam insulated suction line, refrigerant charging connections and hot-gas muffler for each independent circuit.

2.7 INTEGRATED MICROPROCESSOR BASED DDC CONTROLS PACKAGE

A. Pre-wire, assemble, factory mount, and test operating and safety control system consisting of a digital display or gages, on-auto-off switch, motor starters, disconnect switches, power and control wiring. Provide controls, monitoring, programmable set-points, alarms, and BAS as defined below:

1. Automatic Adjustable Operating Controls:
    a. Temperature of chilled water leaving chiller.
    b. Chiller system capacity control based on set-points and system load.
    c. Compressor short-cycling prevention.
    d. Lead/lag for multiple compressors.
    e. Automatic reset on power source failure.
    f. Load limiting.
    g. Start/stop of Dedicated Chilled Water Pumps
2. Normal Operation Monitoring and Open Cover-less Displays:
    a. Hours of operation.
    b. Suction and discharge refrigerant pressures.
    c. Automatic diagnostics.
    d. Number of starts.
    e. On/off compressor status.
    f. Entering and leaving chilled water temperatures.
    g. Status of operation.
    h. Weekly purge cycle totalization if applicable.
    i. Oil pressure.

3. Set-Points:
    a. Leaving chilled water temperature.
    b. Leaving heating water temperature.
    c. Date/time.
4. Automatic Chiller Shut-Down Safety Controls and Alarm:
    a. Automatic Reset:
        1) Chilled water flow interlock.
        2)
        3) Voltage protection (over/under).
        4) Phase reversal protection.
    b. Manual Reset:
        1) Evaporator low pressure.
        2) High motor winding temperature.
        3) Low chilled water temperature.
        4) Low chilled water flow.
        5) High condenser refrigerant discharge pressure.
        6) Motor current overload and phase loss.
        7) Low oil flow.
    c. Remote Alarm: Activate remote, audible bell upon safety shutdown of chiller.
5. Building Automation System (BAS) Communications via Shielded Cable:
    a. Minimum Data Transmission to BAS:
        1) All system operating conditions.
        2) Capacity control information.
        3) Safety shutdown conditions.
    b. Minimum Operating Commands from BAS:
        1) Remote unit start/stop.
        2) Remote chilled water reset.

B. Controller shall have minimum 40-character liquid crystal display in English and numeric data in English units. Provide sealed keypad with password protection for operator interface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive chillers for compliance with installation tolerances and other conditions affecting performance and maintenance of chillers.

B. Examine proposed route of moving chillers into place and verify that it is free of interference's.

C. Verify piping roughing-in locations.

D. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install chillers according to manufacturer's written instructions.

B. Install chillers plumb and level, and anchor. Support units as described below, using the vibration control devices indicated. Vibration control devices are specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."

1. Support floor-mounted units on concrete equipment bases using neoprene pads. Secure units to anchor bolts installed in concrete equipment base.

2. Support ground-mounted condenser units on concrete equipment pad or structural steel stand using neoprene pads.

C. Install vibration isolators according to isolator manufacturer's written instructions.

D. Install chiller accessories which have been shipped loose or unassembled for shipment purposes.

E. Maintain manufacturers recommended clearances for service and maintenance.

F. Install piping connections maintaining clearances for service and maintenance of chillers.

1. Refer to 232300 Refrigerant Piping for additional information.

G. Install flange or mechanical coupling connections at chillers.

H. Install flexible pipe connections for chillers mounted on vibration isolators.

I. Install shutoff valves, pressure gauges and temperature gauges at chiller inlet and outlet connections.

3.3 ELECTRICAL CONNECTIONS

A. Refer to Division 26 Sections for wiring devices, wires and cables, and electrical installation requirements.

B. Install and connect proof of flow device switches.

C. Install and connect remote chiller control panel.

D. Ground equipment.

1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer'' published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 MANUFACTURER'S FIELD SERVICES

A. Provide services of a factory-authorized service representative to supervise field assembly of components and installation of chillers, including piping, electrical and control connections, and to report results in writing.

B. Supply initial charge of refrigerant and oil if not completely factory charged.

C. Demonstrate system operations and verify specified performance.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. Clean finishes to remove dust and dirt.

B. Touch up scratches in unfinished surfaces to restore corrosion resistance.

C. Touch up scratches in finished surfaces to restore finish.

D. Comb fins of outdoor condenser coils.

3.6 STARTUP

A. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate proper operation of equipment, accessories and controls.

B. Start-up Service:

1. Evacuate, dehydrate, vacuum pump and charge with specified refrigerant, and leak test in accordance with manufacturer's instructions, if not factory charged.

2. Perform lubrication service, including filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer.

3. Verify the motor amperage conforms to manufacturer's data.

4. Do not place chillers in sustained operation prior to initial balancing of mechanical systems for interface with chillers.

3.7 TRAINING:

A. At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for

a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 237333 - INDOOR INDIRECT-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Heating and Ventilating Unit.

B. Indirect-Fired gas furnace.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, rated capacities, electrical characteristics, furnished specialties, and accessories. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

1. Fans: Include certified fan performance curves with system operating conditions indicated and certified fan sound power ratings.

2. Filters: Include airflow performance and MERV ratings.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and methods of field assembly, components, and location and size of each field connection.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Wiring Diagrams: Submit wiring diagrams detailing the manufacturer's electrical requirements for power supply wiring for units. Submit manufacturer's 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.

D. Startup service reports.

E. Operation and Maintenance Data: For indirect-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of indirect-fired heating and ventilating units and are based on the specific system indicated.

B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

C. 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.

D. ANSI Compliance: Comply with ANSI Z21.47 "Gas-Fired Central Furnaces".

E. NFPA Compliance:

1. NFPA 54 "National Fuel Gas Code".
2. NFPA 70 "National Electric Code"..

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below of indirect-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Stainless Steel Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.5 SPARE PARTS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each unit.
2. Fan Belts: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. AbsolutAire

B. Applied Air

C. Captive-Air Systems, Inc.

D. Engineered Air.

E. Greenheck.

F. Hastings Industries; Division of Eric, Inc.

G. Modine Mfg. Co.; Commercial HVAC&R Division.

H. Reznor-Thomas & Betts Corporation; Mechanical Products Division.

I. RuppAir Management Systems

J. Titan Air

2.2 PACKAGED HEATING AND VENTILATING UNITS

A. General: Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas furnace to be installed outside or inside the building as shown on the drawings.

1. Provide cooling package with units where specified on the drawings.

B. Cabinet: Construct of galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Provide floor plate of minimum 18 gauge galvanized steel. Form walls, roofs and floors with at least two breaks at each joint.

1. Indoor Units: Provide single or double wall construction per manufacturer's standard offering and manufacturer's standard finish.

2. Outdoor Units: Provide double wall construction with cabinet fully weatherized and finished with heat resistant, baked enamel or powder coated paint rated for outdoor installation. Slope roof for drainage.

C. Access Panels: Provide lift-out or piano-hinged access panels with cam-lock fasteners for furnace and fan motor assemblies. Provide access panels on both sides of unit where needed to access components for maintenance.

D. Internal Insulation: Provide fiberglass blanket or board insulation, complying with ASTM C 1071, Type I or Type II.

1. Indoor Units: Insulate the furnace and fan sections with minimum 1 inch of insulation. For units with single wall construction, provide neoprene coated or foil faced insulation.

2. Outdoor Units: Insulate the complete unit with minimum 2 inches of insulation.

3. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of unit.

4. Insulation Adhesive: Comply with ASTM C 916, Type I.

5. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging insulation when applied as recommended by manufacturer and without causing air leakage.

E. Configuration:

1. Indoor Units: Provide horizontal or vertical units with inlet and outlet locations as shown on the drawings. For non-ducted units, provide discharge plenum or cowl with louvers as indicated on the drawings.

2. Outdoor Units: Provide horizontal units with inlet and outlet locations as shown on the drawings.

F. Fan, Motor and Drive:

1. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings.

2. Motor: Provide open drip proof, single-speed motor. Provide totally enclosed motor if installed in outdoor environment. Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment" for additional requirements.

3. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

   a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

   b. Belts: Oil resistant, non-sparking and non-static; in matched sets for multiple-belt drives.

   c. Belt Guards: Comply with requirements specified by OSHA.

4. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric or spring isolators.

   a. Provide restrained isolators in seismic locations.

G. Air Filters: Provide air filters of thickness and type as scheduled on the drawings.

1. Comply with NFPA 90A.

2. Cleanable Filters: Cleanable metal mesh.

3. Disposable Panel Filters: Factory-fabricated, flat-non-pleated or pleated type filters, with holding frames and with a minimum efficiency report value (MERV) as scheduled.

   a. Media: Interlaced glass, polyester or cotton fibers.

   b. Frame: Beverage board with perforated metal retainer or metal grid on outlet side.

H. Dampers: Dampers and their operators shall comply with performance requirements specified in Division 23 Section "Instrumentation and Control Devices for HVAC."

1. Provide low-leakage, double-skin, airfoil-blade, galvanized steel dampers with compressible jamb seals and extruded-vinyl blade edge seals.

2. Provide parallel blade dampers for two-position operation.

3. Provide opposed blade dampers for modulating operation.

I. Controls: Provide controls and control devices as required to meet the control diagrams, points list and sequences of operation on the drawings including communication with the building automation system (BAS). Refer to Division 23 section "Direct Digital Control for HVAC" for control equipment.

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

2. Control Panel: Surface-mounted or recessed with trim ring, remote panel, with engraved plastic cover, and the following lights and switches:

   a. On-off or On-off-auto fan switch.

   b. Summer-winter-off or Heat-vent-cool switch with automatic changeover.

   c. Supply-fan operation indicating light.

d. Heating operation indicating light.

e. Thermostat.

f. Damper position potentiometer.

g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.

h. Safety-lockout indicating light.

3. Control Devices: Reference Division 23 section “Instrumentation and Control Devices for HVAC” for specification of control devices.

a. Remote Thermostat.

b. .

c. Static-Pressure Transmitter.

d. Timer.

4. DDC: Stand-alone control module for link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 section "Direct Digital Control for HVAC."

a. Provide start and stop interface relay, and relay to notify DDC system alarm condition.

b. Provide hardware interface or additional sensors as follows:

1) Room temperature.

2) Discharge-air temperature.

3) Furnace operating.

J. Electrical

1. Provide unit complete with starters, variable frequency drives, motors, internal thermal overload protection and safeties required for normal operation.

2. Factory wire all factory installed components for single point field connection.

3. Provide disconnect switch as scheduled on the drawings.

2.3 INDIRECT-FIRED GAS FURNACE

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and NFPA 54.

1. AGA Approval: Designed and certified by and bearing label of AGA.

2. Burners:

a. Material:

1) Stainless steel.

b. Gas Control Valve: Single stage, multiple stage or modulating as specified on the drawings.

c. Fuel: Natural or propane gas as specified on the drawings.

d. Minimum Thermal Efficiency: 80 percent.

e. Ignition: Electronically controlled electric spark with flame sensor.

f. High-Altitude Model: For Project elevation above sea level.

B. Venting: Provide vent option as required for the unit capacity and installation location.

1. Gravity vented.

2. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

C. Combustion-Air Intake: For indoor units, provide separate combustion-air intake and vent terminal assembly.

D. Indoor Unit External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.

E. Outdoor Unit External Housing: Weatherproof steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.

1. External Casing and Cabinet Finish: Baked enamel or powder coating over corrosion-resistant-treated surface in color to match fan section.

F. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.

G. Heat Exchanger:

1. Stainless steel.

H. Heat-Exchanger Drain Pan: Stainless steel.

I. Safety Controls:

1. Vent Flow Verification: Differential pressure switch to verify open vent or flame rollout switch.

2. Control Transformer: 24-V ac.

3. High Limit: Thermal switch or fuse to stop burner.

4. Gas Train: Regulated, redundant, 24-Vac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.

6. Gas Manifold: Safety switches and controls to comply with ANSI standards.

7. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.

8. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.

9. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

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 installation of indirect-fired heating and ventilating units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop -air units will be installed.

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

3.2 COORDINATION

A. Coordinate size and location of concrete equipment bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 23 Section “Common Work Results for HVAC.”

B. Coordinate size, location and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

3.3 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

C. Secure roof-mounted units to roof equipment supports and grade-mounted units to curbs or base. Refer to the drawings for the type of support required for each unit.

1. Refer to Section “Hangers and Supports for HVAC Piping and Equipment” for standard roof curbs.

2. Refer to Section “Vibration Isolation For HVAC” for vibration isolation curbs.

D. Provide restrained isolators for seismic control. Refer to Division 23 Section “Seismic Controls for Mechanical” for seismic bracing requirements.

E. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.

3.4 CONNECTIONS

A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

1. Connect gas piping to unit according to requirements of Division 22 Section "Natural Gas Systems”. Provide union with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.

B. Duct Connections: Duct installation requirements are specified in Division 23 section "Metal Ducts". Drawings indicate the general arrangement of ducts. Connect supply and return ducts to units with flexible duct connectors. Flexible duct connectors are specified in Division 23 section "Air Duct Accessories."

C. Ground equipment according to Division 26."

D. Connect power wiring according to Division 26.

E. Connect control wiring according to Division 23 Section “Direct Digital Control for HVAC”.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators and seismic restraints.
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.
11. Start unit according to manufacturer's written instructions.
12. Complete startup sheets and attach copy with Contractor's startup report.
13. Inspect and record performance of interlocks and protective devices; verify sequences.
14. Operate unit for run-in period recommended by manufacturer.
15. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
16. Calibrate thermostats.
17. Adjust and inspect high-temperature limits.
18. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.

19. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

20. Measure and record airflow. Plot fan volumes on fan curve.

21. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.

    b. Alarms.

22. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

B. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.

C. Prepare written report of the results of startup services.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

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.

3.7 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 237333

SECTION 237413 - OUTDOOR PACKAGED HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged roof top unit.

B. Unit Controls.

C. Roof mounting curb and base.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, and furnished specialties and accessories. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

C. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components

2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

D. Wiring Diagrams: Submit wiring diagrams detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's 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.

E. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

F. Operation and Maintenance Data: Submit maintenance data and parts list for each rooftop unit, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Codes and Standards:

1. Gas-fired furnace section construction shall be in accordance with AGA safety standards. Furnace section shall bear the AGA label.

2. AHRI Compliance:

   a. Testing and rating of rooftop units of 65,000 Btu/hr capacity or over shall be in accordance with AHRI 340/360 "Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment".

   b. Testing and rating of rooftop units under 65,000 Btu/hr capacity shall be in accordance with AHRI 210/240 "Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment".

   c. Capacity ratings for air-to-air energy recovery equipment shall comply with AHRI 1060 "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment".

   d. Capacity ratings for water coils shall comply with AHRI 410 "Forced-Circulation Air- Cooling and Air-Heating Coils".

   e. Sound testing and rating of units shall be in accordance with AHRI 270" Sound Performance Rating of Outdoor Unitary Equipment". Units shall bear Certified Rating Seal.

3. Refrigerating system construction of rooftop units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

4. Rooftop units shall be listed by UL and have UL label as a unit. Comply with UL 1995 "Heating and Cooling Equipment".

1.4 FLAMMABLE REFRIGERANTS

A. Equipment with refrigeration systems using Group A2L refrigerants shall meet all requirements of ASHRAE Std 15 and this section.

B. Listing and Installation Requirements:

1. Listed in accordance with UL 484 or UL 60335-2-40/CSA C22.2 No. 60335-2-40.

2. The nameplate shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing.

3. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing.

C. Refrigeration systems shall have an integral refrigerant detection system that meets the following requirements as documented in ASHRAE Std 15:

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.

2. Field recalibration of refrigerant detection system shall not be permitted.

3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.

4. Have access for replacement of refrigerant detection system components.

5. Have self-diagnostics to determine operational status of the sensing element.

6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.

7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, -1%).

D. Manufacturer's refrigeration mitigation action shall be completed in not more than 15 seconds after the initiation of the output signal of the equipment's integral refrigerant detection system and shall be maintained for at least 5 minutes after the output signal has reset.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept products, with factory-installed shipping skids and lifting lugs. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units. Inspect for damage.

B. Protect units from physical damage by storing off site or in locked, protected area until roof mounting curbs are in place, ready for immediate installation of units.

1.6 SPECIAL WARRANTY

A. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

1. Warranty Period: 5 years from date of substantial completion.

1.7 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling unit.

1. One set of matched fan belts for each belt driven fan.

2. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.

3. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS:

A. Carrier Air Conditioning; Div of Carrier Corp.

B. Greenheck.

C. Johnson Controls, Inc.

D. Lennox Industries, Inc.

E. Trane (The) Co; Div of American Standard Inc.

F. Valent Air.

G. York Int'l Corp.

2.2 MANUFACTURED UNITS

A. General: Roof or slab mounted units, factory assembled, prewired and tested,

B. Description: Self-contained, packaged unit consisting of compressors, condensers, evaporator coils, heating system, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics shall be as scheduled on the Drawings.

C. Refrigerant: Provide rooftop units designed to operate with refrigerant as scheduled on the drawings.

2.3 FABRICATION

A. Cabinet: Provide manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a knockouts for electrical and piping connections, and an exterior condensate drain connection, and lifting lugs.

1. Bottom Duct Connections: Provide steel or aluminum walking grate on structural supports where connections are located in sections accessible by personnel for maintenance.

B. Insulation: Minimum of 1" thick, 1.5 pound density thermal insulation.

C. Condensate Drain Pan: Provide galvanized or stainless steel condensate drain pan sloped to drain connection.

D. Filters Section: Provide filter housing of material matching the unit casing with gasketed filter media holding frames. Provide access panel large enough for filter replacement with continuous gasketing and positive locking devices.

E. Roof Curbs: Refer to Section "Hangers and Supports for HVAC" for pre-engineered roof equipment supports and Section "Vibration Isolation for HVAC Piping and Equipment" for vibration isolated equipment support bases.

2.4 FANS

A. Supply Fans: Provide forward-curved or backward inclined, centrifugal fan wheel, V-belt drive with adjustable variable pitch motor pulley or direct drive, rubber isolated hinge mounted high efficiency motor and permanently lubricated motor bearings.

B. Condenser Fans: Provide propeller-type, direct-driven fans, resiliently mounted with fan guard, with permanently lubricated bearings.

C. Variable Air Volume Control: Provide variable frequency drives to modulate fans to meet specified sequence of operation. Refer to Division 23 section "Variable Frequency Drives".

2.5 MOTORS:

A. Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.

2.6 AIR FILTRATION

A. Pre-Filters Section: Provide 4" thick fiberglass throwaway pleated filters in filter rack, with maximum face velocity of 400 fpm and minimum MERV rating per ASHRAE 52.2 of MERV 13.

2.7 GAS-FIRED HEAT EXCHANGERS:

A. Provide aluminized steel construction for gas-fired heat exchangers and burners. Provide heat exchangers and burners designed for staged operation as scheduled or noted on the drawings with minimum efficiency of 80 percent. Provide single gas connection.

B. Gas Burner: Atmospheric or power-vented type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.

C. Operating Controls: Provide the following controls for the gas-fired heat exchangers:

1. Intermittent pilot ignition;
2. Electronic spark ignition system;
3. High limit cutout;
4. Forced draft proving switch;
5. Flame roll-out switch.

2.8 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant.

C. Provide interlaced coils in multiple stage units to ensure full coverage over coil face.

D. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of refrigerant.

E. Provide corrosion protective coating where scheduled.

F. Provide 1 inch factory installed flexible elastomeric insulation around the suction and liquid lines not directly located above a condensate drain pan. If any piping is exposed to sunlight, provide UV protective coating.

2.9 HOT GAS REHEAT COIL:

A. Provide hot gas reheat coil with staged or modulating control for reheat during dehumidification operation. Size hot gas reheat coil capacity to maintain space temperature when unit is operating in the dehumidification mode with no load in the space. Refer to control drawings.

2.10 COMPRESSORS:

A. Provide serviceable, semi-hermetic, or fully hermetic compressors, complete with integral vibration isolators, crankcase heaters which de-energize during compressor operation.

B. Units shall have the following capacity control measures to prevent excessive compressor short cycling and prevent evaporator coil from freezing:

1. Inverter scroll compressor as the first stage.

C. Accessories: Thermal expansion valves, filter dryers, sight glasses, compressor service valves, liquid line service valves; minimum of 2 refrigerant circuits for units having 2 or more compressors.

2.11 CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

B. Provide corrosion protective coating where scheduled.

C. Provide refrigerant pressure switches to cycle condenser fans

2.12 MIXED AIR CASING

A. General: Dampers and their operators shall comply with performance requirements specified in Division 23 Section “Instrumentation and Control Devices for HVAC.”

B. Outdoor Air Damper:

1. Provide outside air damper constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven.

2. Refer to schedules and control diagrams on the drawings for quantity, capacity and control method of the outdoor air dampers of each unit.

C. Economizer Control:

1. Provide economizer system complete with return and outside air dampers, outside air filter, fully modulating electric control system with dry bulb or enthalpy control as noted on the drawings, and adjustable mixed-air thermostat.

2. System shall have 100 percent outside air capability.

3. Provide automatic changeover through adjustable control device.

D. Relief Damper: Provide a relief damper with control type as scheduled on the drawings.

2.13 OPERATING CONTROLS:

A. Provide solid-state control board and components that contain at a minimum the following features in addition to control features specified in the contract documents:

1. Indoor fan on/off delay.
2. Default control to ensure proper operation after power interruption.
3. Service relay output.
4. Unit diagnostics and diagnostic code storage.
5. Field-adjustable control parameters.
6. Minimum run time.
7. Return-air temperature limit.
8. Fan-proving switch to lock out unit if fan fails.

B. DDC Interface: Install stand-alone control module providing link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 section "Direct Digital Control for HVAC".

C. Space Sensors: Temperature sensors, carbon dioxide sensors, and humidity sensors called out by the drawings shall be provided by the manufacturer of the packaged heating and cooling units, shipped loose for field installation in the return/exhaust ducts by the Division 23 Contractor. All sensors shall be communicating devices visible through the building automation system interface.

2.14 SAFETY CONTROLS:

A. Provide safety controls for the following:

1. Low pressure cutout, manual reset type;
2. High pressure cutout, manual reset type;
3. Compressor motor overload protection, manual reset type;
4. Anti-recycling timing device;
5. Adjustable low-ambient lockout;
6. Oil pressure switch.

2.15 ELECTRICAL

A. Provide a 125 VAC, 20 amp duplex convenience receptacle mounted to unit ready for field wiring through the curb with a cover UL listed for wet and damp locations when in use.

B. Unit power connection shall be either through unit cabinet or within roof curb perimeter.

C. Rooftop units shall be designed to meet the minimum short-circuit withstand rating specified on the drawings.

2.16 ACCESSORIES

A. Units shall include the following accessories where scheduled or shown on the drawings:

1. Remote Control Panel: Furnish panel for remote mounting containing control of heating, cooling, evaporator fan, and outdoor damper; and indicator lights for up to 6 unit functions.
2. Anti-recycling control to automatically prevent compressor restart for 5-minutes after shutdown.
3. Low ambient control head pressure control, designed to operate at temperatures down to temperature specified on the drawings.
4. Provide guards to protect the condenser coil from hail or other damage.
5. Thermostat: Assembly shall provide for staged heating and cooling with manual or automatic changeover on standard subbase.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas and conditions under which rooftop units are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. For roof installed units, verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

D. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ROOFTOP HEATING AND COOLING UNITS

A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Secure roof-mounted units to roof equipment supports and grade-mounted units to curbs or base. Refer to the drawings for the type of support required for each rooftop unit.

1. Refer to Section “Hangers and Supports for HVAC Piping and Equipment” for standard roof curbs.
2. Refer to Section “Vibration Isolation For HVAC” for vibration isolation curbs.

C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

D. Ductwork: Refer to Division-23 section "Metal Ducts". Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

E. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties.

1. Condensate Drain Piping: Route condensate drain to nearest roof drain or to location shown on the drawings. Provide trap at connection to drain pan with depth as noted on the drawings and install cleanouts at changes in direction (refer to manufacturer's recommendations for any additional requirements). Size condensate drain piping in accordance with local code and as shown on the drawings.

F. Connect condensate drain piping to the unit with appropriate trap. Verify that the piping material and installation is in accordance with Division 22 requirements.

G. Connect gas piping to gas-fired heat exchanger according to requirements of Division 22 section "Natural Gas Systems." Provide union with sufficient clearance for burner removal and service.

3.3 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Section "Testing, Adjusting and Balancing for HVAC." Tighten belts as required for proper operation.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.4 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
7. Comb coil fins for parallel orientation.
8. Install clean filters. Do not operate air handling unit without pre-filters installed.
9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
10. Disable automatic temperature control operators.

B. Start-Up Services: Provide the services of a factory-authorized service representative to start-up rooftop units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.

b. Measure and record motor electrical values for voltage and amperage.

c. Shut unit down and reconnect automatic temperature control operators.

d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 237413

SECTION 260010 - GENERAL ELECTRICAL REQUIREMENTS

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 and to all following sections within Division 26.

1.2 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. The Contractor will show the materials and their relationship to one another, including sizes, shapes, locations, and connections. The Contractor also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."

2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."

3. Provide: "To furnish and install complete, and ready for the intended use."

4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division.

    a. A Consultant to, and an authorized representative of, the Owner, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Owner”.

6. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is the “Engineer”.

7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.

9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified

B. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

C. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

D. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

3. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.

E. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Sub-base: as used in this section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.

3. Sub-grade: as used in this section refers to the compacted soil immediately below the slab or pavement system.

4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.4 REFERENCE STANDARDS

A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC	International Building Code
ADA	Americans with Disabilities Act
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufactures' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.

G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.

C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.

D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.6 MEASUREMENTS AND LAYOUTS:

A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating

proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

1.8 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data

not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

1.9 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer and Owner the following:

   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

   c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.

   d. Same warranty will be furnished for proposed substitution as for specified Work.

   e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

   f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.

   a. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.

4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. The following must be received before electronic drawing files will be sent:

1. Engineer’s release agreement form

2. Payment

1.11 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish the Operation and Maintenance Manuals to the Contract Administrator, for Engineer’s review, and for the Owner’s use.

1. Refer to Division 01 for acceptance of electronic manuals for this project. If not specified in Division 1, provide manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

a. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and

password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

2. If Division 01 requires paper manuals, provide four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

1.13 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division

1.14 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. Also warrant the following additional items:

1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
2. All raceway seals are effective.
3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.

E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced

polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

   a. Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.

   b. If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

1.18 FIELD CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the site prior to submitting bid to determine the nature and extent of work involved.

2. Schedule work in the existing building with the Owner.

3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, Light fixtures, equipment, raceways, equipment supports or foundations and materials.

4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.

5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.

6. Finish material will be installed under other divisions.

7. Obtain permission from the Contract Administrator for roof penetrations and channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. For work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.]

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Use of explosives is not permitted.

D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 SOIL MATERIALS

A. Sub base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.

C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than two inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new work.

B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

C. Notify Contract Administrator immediately of any dangerous conditions that exist on the job site, as they are discovered, before demolition, during selective demolition or before remodel work begins.

3.3 EXISTING UTILITIES

A. Prepare and submit a schedule of anticipated utility outages indicating dates and duration. Schedule

B. Schedule and coordinate with the utility companies, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal utility services from any existing utility line. Include all premium time required for all such work in the bid.

C. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or utility companies without additional cost.

D. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.

E. Make repairs and restoration of utilities before workers leave the project at the end of the workday in which the interruption takes place.

F. Include in bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.4 WORK IN EXISTING FACILITIES

A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the site prior to submitting a bid, to determine the nature and extent of work involved.

B. Schedule work in the existing facility with the Owner.

C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.

D. Remove all of these articles that are not required for the new work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.

E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner’s written permission.
3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
4. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical

fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.

G. Finish materials are specified in other divisions.

H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.

I. Penetrate roofs, channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all penetrations and channeling not specifically noted on the Drawings.

J. Provide new, typewritten card directory for distribution equipment (including but not limited to load centers, panelboards, switchboards and switchgear) where changes occur under this scope of work. Indicate exact loads served by each existing circuit breaker or switch. Where circuit designations are not specifically indicated on the Drawings, provide a unique identifier for each updated circuit within the directory.

K. Coordinate work with phasing drawings to properly stage transitions of work to provide power to existing, new and temporary loads. Monitor loads on distribution system to ensure shifting of loads does not overload electrical equipment.

L. Work in common areas must be reviewed and approved by the Contract Administrator and Owner prior to commencement of the work.

1. Contractor shall minimize any disruption and disturbances to areas outside zones scheduled for work. All work within other areas must be coordinated with and approved by the Owner.

3.5 PERMITS

A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.6 TEMPORARY ELECTRICAL SERVICE AND WIRING

A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.

B. In existing facilities, with Owner's approval, Contractor may utilize the existing electrical system as the source of temporary power. Coordinate the point of connection and method of connection to the existing system with the Owner's Representative.

C. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.

D. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.

E. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

F. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.

G. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).

H. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.

I. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.

J. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.

K. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.7 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:

    a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.

b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

3.8 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Maintain all code required clearances and clearances required by manufacturers.

3.9 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.10 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.

C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.

D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.

E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

F. Slope sides of excavations to comply with local, state, and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state, and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.

2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.

5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas use excavated or borrowed materials.

O. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less that 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.

Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with

ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.11 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Engineer prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.12 PAINTING

A. Refer to Division 09 Section “Painting” for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.13 CLEANING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Electrical Contractor shall clean material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment.

C. Damaged finishes shall be touched-up and restored to their original condition

3.14 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.

B. Check motors for alignment with drive and proper rotation, and adjust as required.

C. Check and test protective devices for specified and required application, and adjust as required.

D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.

E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.

G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.

H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.

J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.

K. Refer to individual sections for additional and specific requirements.

3.15 START-UP OF SYSTEMS

A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.

B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.

C. Adjust taps on each transformer for rated secondary voltages.

D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.

E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.

F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.

G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.16 TEST REPORTS

A. Perform tests as required by these Specifications and submit the results to the Contract Administrator, for Engineer's review. Record the results, date and time of each test and the conditions under which the test was conducted. Include a copy of the finalized test results, with corrections made, in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.

B. For specific testing requirements of special systems, refer to the Specification section that describes that system. The Contractor shall provide the following to facilitate the testing of the electrical systems:

1. Perform tests as described in the individual sections;

C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:

1. Building service entrance voltage and amperes at each phase.
2. Electrical service grounding conditions and grounding resistance.
3. Proper phasing throughout the entire system.
4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
5. Phase voltages and amperes at each three-phase motor.
6. Test all wiring devices for electrical continuity and proper polarity of connections.

D. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

3.17 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit complete Operation and Maintenance Data.
2. Submit complete Record Drawings.
3. Perform all required training of Owner's personnel.
4. Turn over video recordings of training sessions to the Owner.
5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
6. Perform start-up tests of all systems.
7. Remove all temporary facilities from the site.
8. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items the Contractor shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 260010

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:

1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
2. Sleeves and seals for electrical penetrations.
3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
4. Sealing penetrations through noise critical spaces.

DEFINITIONS

B. The following abbreviations apply to this and other Sections of these Specifications:

1. AHJ: Authority(ies) having Jurisdiction
2. ATS: Acceptance Testing Specifications
3. EPDM: Ethylene-propylene-diene monomer rubber
4. MC: Metal Clad
5. N/A: Not Available or Not Applicable
6. NBR: Acrylonitrile-butadiene rubber
7. NRTL: Nationally Recognized Testing Laboratory
8. PCF: Pounds per Cubic Foot

C. The following definitions apply to this and other Sections of these Specifications:

1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":

1. Product data for the following products:
    a. Sleeve seals.
    b. Through and membrane penetration firestopping systems.
    c. Joint sealers
2. Shop drawings for:
    a. Detailed fabrication drawings of access panels and doors.
3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
    a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
    b. Qualifications data for testing agency.
4. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26
    a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor

7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section “Identification for Electrical Systems” for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Contract Administrator and owner prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
    a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
    b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
8. Locking Devices:
    a. In locations accessible to occupants, provide 5-pin or 5-disc type cylinder locks, all access panels keyed alike; provide 2 keys per access panel. Coordinate keying requirements with owner.

2.2 SLEEVES

A. Steel sleeves for raceways and cables:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables:

1. Manufacturers
    a. Josam Mfg. Co.

b. Smith (Jay R) Mfg. Co.

c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.

d. Watts Industries, Inc.

e. Zurn Industries, Inc.; Hydromechanics Div.

2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138- inch thickness as indicated and of length to suit application.

4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.3 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. O-Z/Gedney

e. Pipeline Seal and Insulator, Inc.

3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.

a. Neoprene

4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.

a. Stainless steel

5. Connecting Bolts and Nuts: Provide bolts of length required to secure pressure plates to sealing elements. Include one for each sealing element.

a. Stainless steel

B. JOINT SEALERS

1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.

3. Elastomeric Joint Sealers: Provide the following types:

a. Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in

non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

1) Dow Corning, Dowsil 790
2) Dow Corning, Dowsil 795
3) GE, Silglaze II SCS 2350
4) GE, Silpruf SCS 2000
5) Owens Corning, Energy Complete
6) Pecora, 864 NST
7) Tremco, Spectrem 1
8) Tremco, Spectrem 2

b. Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

1) Dow Corning, Dowsil 786
2) GE, Momentum SCS 1700
3) Pecora, 898 Silicone NST

c. Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:

1) BASF, MasterSeal NP 100
2) Pecora, DyanTrol I-XL
3) Tremco, Dymonic FC

FIRESTOPPING

1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:

a. Manufacturers:

1) 3M Corp., Fire Barrier Sealant
2) Hilti, Inc.
3) Tremco, Tremstop Fyre-Sil
4) Pecora, AC-20 FTR
5) RectorSeal
6) Specified Technologies Inc. Firestop
7) USG, SHEETROCK Firecode Compound

8) Owens Corning Firestopping Insulation

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

D. Comply with NECA 1.

E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.

F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

H. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.2 ACCESS DOORS

A. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.

B. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.

C. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

3.3 SLEEVES AND SLEEVE SEALS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.

C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.

D. Construction in Existing Facilities:

1. Saw cut or core drill existing walls, roofs and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls, roofs or slabs without first coordinating with, and receiving approval from, the Contract Administrator, Owner, or both. Seal sleeves into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Contract Administrator. Provide roofing penetration seals and covers to match existing roofing materials. Coordinate roofing repair of adjacent roofing material with Owner's roofing contractor to provide a waterproof installation.

E. 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. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.

F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

G. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.

2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

H. 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.

I. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.

J. Sleeve Length:

1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.

2. Sleeves through floors: Extend sleeves 2 inches above finished floor level.

K. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or as required to meet seismic criteria; in which case, size sleeves as recommended by the seal manufacturer or per seismic criteria, or both.

L. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

M. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint

N. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

O. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

P. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

Q. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

   a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

   b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.

   c. Install galvanized sheet metal for rectangular sleeves

   d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

R. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

S. Concrete Slab on Grade Penetrations:

1. Provide ½" thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.

T. Elevated Floor Penetrations of waterproof membrane:

1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum ½" annular space between wall pipe and cable or raceway.

2. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

3. Secure waterproof membrane flashing between clamping flange and clamping ring.

4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

U. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.

V. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

W. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

X. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.

2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Z. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

AA. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 JOINT SEALERS

A. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.

2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

B. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

END OF SECTION 260500

SECTION 260502 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.

B. Coordinate with work described in Division 11 Sections for equipment requiring electrical connection.

C. Coordinate with work described in Division 23 Section “Common Work Results for HVAC”.

D. Coordinate with work described in Division 23 Section “Direct-Digital Control for HVAC”.

E. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

F. Determine connection locations and rough-in requirements based on shop drawings.

G. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

H. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product data for the following products for:

1. Special connectors

2. Special conductors or cable assemblies.

C. Shop drawings for:

3. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.

2. Marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 CORDS AND CAPS

A. Attachment Plugs: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.

C. Cord: See Paragraph “Flexible Cords” in Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 ELECTRICAL DEVICES

A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated, specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.3 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturers’ instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.4 EQUIPMENT

A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.

C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

END OF SECTION 260502

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conductors, cables, and cords rated 600V and less.

B. Connectors and terminations rated 600V and less.

1.2 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these specifications:

1. MC: Metal Clad
2. NBR: Acrylonitrile-butadiene rubber
3. NETA ATS: Acceptance Testing Specification.

B. The following definitions apply to this and other Sections of these Specifications:

1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

B. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:
    a. Conductors, cables, and cords rated 600V and less.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

E. Qualification Data: For testing agency.

F. Field quality-control test reports in accordance with NETA ATS:

1. Submit all system and component test results.

G. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

H. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.

I. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

D. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.

3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.

C. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section "Seismic Controls for Electrical Systems" and Division 20 Section "Seismic Controls for MEP/F/T Systems".

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUCTORS AND CABLES - GENERAL

A. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.

1. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger

2. Stranded for all flexible cords, cables, and control wiring.

3. As noted otherwise below.

B. Aluminum conductors are not allowed.

C. Conductor Insulation: Type THHN/THWN-2 or XHHW-2 complying with ICEA S-95-658/NEMA WC70 or as noted otherwise below.

D. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).

E. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre-manufactured whips for light fixtures which may be No. 14 AWG.

F. Conductors installed for site electrical work shall be no smaller than No. 10 AWG CU. All site electrical branch circuit wiring shall be sized such that the maximum branch circuit voltage drop is less than 3 percent.

G. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.

H. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.2 SINGLE CONDUCTORS

A. Manufacturers:

1. Alan Wire
2. Cerrowire
3. Colonial Wire & Cable Co., Inc.
4. Encore Wire Corporation
5. General Cable (Prysmian Group)
6. Northern Cables Inc.
7. Okonite Company
8. Southwire Company

B. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

PHASE	208Y/120V	480Y/277V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray**
Equipment Ground	Green	Green
Isolated Ground	Green/Yellow Stripe	Green/Yellow Stripe

**Except as provided in NFPA 70.

2.3 METAL CLAD CABLE; TYPE MC

A. General:

1. Shall not be used on this project.

2.4 FLEXIBLE CORDS

A. Manufacturers:

1. Cerrowire
2. Southwire

B. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant yellow jacket, extra-hard-usage; Type STO for indoor dry and damp locations; STOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

2.5 CONTROL WIRING

A. Refer to Division 23 Section “Direct-Digital Control for HVAC”

B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.6 CONNECTORS

A. Manufacturers:

1. AMP; Tyco
2. FCI-Burndy
3. Gould
4. Ideal Industries, Inc.
5. Ilsco
6. NSi Industries, Inc.
7. O-Z/Gedney
8. Panduit
9. Thomas and Betts
10. 3-M Electrical Products Division

B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings for copper conductors: Bare copper, 1-hole pad and inspection port.

C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings: Bare copper, 1-hole pad and inspection port.

D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.

E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: flanged fork-tongue type.

F. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

G. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3 - EXECUTION

3.1 PREPERATION

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

C. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.

D. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

E. Where anticipated conductor installed lengths exceed the lengths indicated on the Drawings, notify Contract Administrator. Provide tabulated list of exceeded lengths for review. Increase conductor size, circuit ground size, and conduit size accordingly to meet maximum voltage drop indicated within the calculations.

3.2 INSTALLATION

A. General

1. Unless otherwise indicated on the Drawings on in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.
2. Install in accordance with manufacturer’s instructions.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
6. Seal around cables penetrating fire-rated elements according to Division 07 Section “Penetration Firestopping”.
7. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.
8. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
9. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.
10. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded

conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.

11. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

12. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

13. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply (unless shown or noted otherwise on drawings,) which are in addition to those in NFPA 70:

    a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.

        1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.

        2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

    b. Normal or Non-Essential circuits.

        1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.

        2) The minimum wire size for all conductors in this raceway: No. 10 AWG.

        3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

    c. GFCI-protected circuits.

        1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.

14. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.

15. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.

16. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:

    a. Wet or dry locations, in raceways:

        1) Service entrance: Type THHN/THWN-2, or XHHW-2.

        2) Feeders and branch circuits: Type THHN/THWN-2, or XHHW-2.

        3) Conductors No. 6 AWG and smaller: Types THHN/THWN-2.

        4) Conductors used between a variable frequency drive (VFD) and associated motor: Type XHHW-2.

B. Flexible Cords

1. Refer to Division 26 Section, “Equipment Wiring Systems”, for electrical connections to equipment.

C. Control Wiring

1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.

2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.

   a. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

D. Connections:

1. Apply a zinc based, anti-oxidizing compound to connections.

2. 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.

3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

4. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.

5. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.

   a. Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus

   b. Compression – splices, terminals

   c. Mechanical – where temporary removal is required

6. Do not use terminals on wiring devices to feed through to the next device.

3.3 IDENTIFICATION

A. General: Provide all identification per Division 26 “Identification for Electrical Systems”.

B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:

1. Factory provided colored insulation

2. Color-Coding Conductor Tape.

3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes identify voltage, source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.

E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.

F. 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.

G. Conductors for controls: Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section “Identification for Electrical Systems”. Note conductor identification on record Drawings.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

J. Low voltage cable sheath labels and related manufacturer information shall remain apparent in all exposed applications.

1. Protect exposed cabling labels from painting and overspray (this includes protection of cables in cable tray)

3.4 FIELD QUALITY CONTROL

A. Do not perform insulation resistance tests of the distribution wiring to equipment with the surge protective devices installed. Disconnect surge protective device before conducting insulation resistance tests and reconnect immediately after the testing is over.

B. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. This Section includes:

1. Grounding Electrodes
2. Grounding Conductors
3. Connector Products

1.2 DEFINITIONS

A. The following apply to this and other Sections of these Specifications:

1. Ground ring: Bare underground grounding conductor encircling the building or structure.
2. NETA ATS: Acceptance Testing Specification.
3. PSF: Pounds per Square Foot
4. EMT: Electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. FMC: Flexible metal conduit.
7. GRS: Galvanized Rigid Steel Conduit
8. IMC: Intermediate metal conduit.
9. LFMC: Liquidtight flexible metal conduit.
10. LFNC: Liquidtight flexible nonmetallic conduit.
11. RAC: Rigid Aluminum Conduit
12. RMC: Rigid Metal Conduit
13. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":

1. Product data for the following products:
   a. Electrodes, mechanical and compression connectors, and exothermic connectors .

B. Qualification Data: For Contractor.

C. Quality-Control Test Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record actual locations of all buried electrodes, bonding conductors and ground rings. Indicate dimensions from fixed structural elements.

1.4 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

2. Marked for intended use.

3. Comply with UL 467.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

A. Manufacturers:

1. ABB, Inc.

2. Advanced Lightning Technology (ALT)

3. AFL Global

4. Boggs, Inc.

5. Burndy; Hubbell.

6. Cooper Power; Eaton.

7. Copperweld Corp.

8. ECN/Korns; Division of Robroy Industries.

9. Erico; nVent.
10. Galvan Industries, Inc.
11. Greaves Corp.
12. Harger.
13. Hastings Fiber Glass Products, Inc.
14. Heary Brothers Lightning Protection Co.
15. Ideal Industries, Inc.
16. ILSCO.
17. Lightning Master Corp.
18. Lyncole XIT Grounding; Division of VFC.
19. O-Z/Gedney Co.; Emerson.
20. Panduit, Inc
21. RACO; Hubbell, Inc.
22. Robbins Lightning, Inc.
23. Superior Grounding Systems, Inc.

2.2 GROUNDING ELECTRODES

A. Ground Rods: UL-listed:

1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 13 mils.
2. Stainless steel; Type 304.
3. Size: 5/8 inch by 8 feet Provide sectional types when longer rods are indicated.

B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a bare conductor sized, at a minimum, for the size of the connecting grounding electrode conductor.

C. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.

2.3 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Material:

1. Copper-clad aluminum.
2. Copper.

C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.

D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.

E. Underground Conductors:

1. Tinned-copper conductor.
2. No. 2/0 AWG minimum
3. Stranded, unless otherwise indicated.

F. Bare Copper Conductors:

1. Solid Conductors: Comply with ASTM B 3
2. Concentric-Lay Stranded Conductors: Comply with ASTM B 8.
3. Tinned Conductors: Comply with ASTM B 33.

G. Copper Bonding Conductors:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.

2.4 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors.

C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

1. Company symbol and/or logo.
2. Catalog number.
3. Conductors accommodated.
4. Installation die index number or die catalog number is required.
5. Underwriters Laboratories “Listing Mark:”.
6. The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL Standard ANSI/UL467.

D. Cast connectors: copper base alloy according to ASTM B 30.

E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental

to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.

2. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.

3. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Application:

1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

2. Underground Grounding Conductors: Unless noted otherwise, bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

C. Grounding Electrode System: Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

1. Provide continuous grounding electrode conductors without splice or joint.

2. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

3. Ground Rod Electrodes:

a. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

b. Unless otherwise indicated, install ground rod electrodes vertically.

1) Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

2) Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

c. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70. If depth is unachievable, notify Contract Administrator and Engineer.

d. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

e. Verify that final backfill and compaction has been completed before driving rod electrodes.

f. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.

4. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

5. Metal In-Ground Support Structures: Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

D. Equipment Grounding Conductors:

1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

2. Install equipment grounding conductors in all feeders and branch circuits.

3. In branch circuit and feeder raceways, use insulated equipment grounding conductors.

4. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

E. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.

G. Bonding: Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:

1. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps

directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

2. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

4. Bond metallic elements likely to become energized or where indicated on the Drawings, including but not limited to fences around electrical equipment and metal drain bodies near pools or electrical equipment.

5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

6. Common Ground Bonding 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 PVC conduit.

3.3 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to 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.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:

1. Connecting conductors together.

2. Connecting conductors to ground rods, except at test wells.

3. Connecting conductors to building steel.

4. Connecting conductors to plates.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a

visible indication that a connector has been adequately compressed on grounding conductor.

1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:

   a. Connecting conductors together, except below grade.

   b. Connecting conductors to building steel.

D. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding 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.

1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:

   a. Connecting conductors to ground rods at test wells.

   b. Connecting conductors to pipes.

E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

B. Pad-Mounted Transformers: Install two ground rods and counterpoise encircling the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 6 inches from the foundation.

3.5 IDENTIFICATION

A. Provide identification as specified in Division 26 “Low-Voltage Electrical Power Conductors and Cables” and “Identification for Electrical Systems”.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

4. Inspect and test in accordance with NETA ATS, except Section 4.

5. Perform inspections and tests listed in NETA ATS, Section 7.13.

6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

7. Perform point–to–point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

8. Test Values:

   a. The resistance between the main grounding electrode and earth ground shall be no greater than 5 ohms.

   b. Equipment Rated 500 kVA and Less: 10 ohms.

   c. Equipment Rated 500 to 1000 kVA: 5 ohms.

   d. Equipment Rated More Than 1000 kVA: 3 ohms.

   e. Substations and Pad-Mounted Switching Equipment: 5 ohms.

   f. Manhole Grounds: 10 ohms.

9. Minimum system neutral–to-ground insulation resistance: one megohm.

10. Investigate point-to-point resistance values that exceed 0.5 ohms.

    a. Check for loose connections.

    b. Check for absent or broken connections.

    c. Check for poor quality welds.

    d. Consider other reasons.

11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements

12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

13. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.7 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

3.8 EXISTING INSTALLATIONS

A. Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Where applicable, verify the neutral and ground are properly bonded at the point of service entrance. Notify the Owner and the Engineer of any existing deficiencies.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
7. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.
2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

C. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Submit fabrication drawings and product literature.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

E. Seismic Requirements: Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEP/F/T Systems”.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Rooftop support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

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 and applicable building code.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. General:

1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Use corrosion resistant materials suitable for the environment where installed.

1. Manufacturers:

a. Allied Tube & Conduit; Atkore International.

b. Eaton

c. Erico; nVent.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Atkore International.

g. Wesanco, Inc.

2. Metallic Coatings:

a. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

b. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

3. Channel Dimensions: Selected for applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Conduit Straps: One-hole or two-hole type.

2. Conduit Clamps: Bolted type unless otherwise indicated.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

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. Battery-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) Powers Fasteners, Inc;

5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless 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.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

H. Wire Rope Hanging Systems:

1. Manufacturers:

   a. Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.

4. Wire Rope: Zinc coated, stainless steel or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

5. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

2.2 FABRICATED METAL CONDUIT OR 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.

C. Rooftop support assemblies: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane.

1. Conduit supports: Unless noted otherwise, surface mounted fittings not requiring any attachment to the roof structure and not penetrating the roofing assembly with support fixtures.

2. Equipment supports: Attachment fittings for connection to roof structure.

D. Base Sizes: As required to prevent overturning and to distribute load sufficiently to prevent indentation of roofing assembly.

E. Mounting Height: Provide minimum clearance of 6 inches under supported components to top of roofing.

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. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.

C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.

D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:

1. Minimum rod size shall be 1/4 inch (6 mm) in diameter, unless otherwise indicated.

a. Equipment Supports: 1/2 inch diameter minimum.

b. Busway Supports: 1/2 inch diameter minimum.

c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter minimum.

d. Trapeze Support for Multiple Conduits: 3/8 inch diameter minimum.

2. Spacing supports for EMT, IMC, and RMC shall be as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:

a. two-bolt conduit clamps

b. single-bolt conduit clamps

G. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Supported load shall not exceed manufacturer's recommended load rating.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Install in accordance with manufacturer's instructions.

E. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

F. 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 (90 kg).

1. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

G. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

H. Do not use products for applications other than as permitted by NFPA 70 and product listing.

I. Remove temporary supports when no longer required.

J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

K. 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. To Steel:
    a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts

b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69

6. To Light Steel: Sheet metal screws.

7. 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 by means that meet seismic-restraint strength and anchorage requirements.

L. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

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.

D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:

1. Accessible to untrained personnel.

2. Located within confined spaces.

E. Rooftop support assemblies:

1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.

2. Equipment supports: Coordinate installation of supports with roofing material installation.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Concrete”."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 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 (0.05 mm).

B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUREMENTS

1.1 SECTION INCLUDES

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. RAC: Rigid Aluminum Conduit
7. RMC: Rigid Metal Conduit
8. RNC: Rigid Nonmetallic Conduit

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Shop drawings for:

1. Detailing fabrication and installation for custom enclosures.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.

2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

2. Marked for intended use.

C. Comply with NFPA 70.

1.6 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 "Seismic Controls for Electrical" and Division 20 Section "Seismic Controls for MEP/F/T Systems".

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

A. Metal Conduit and Tubing

1. Manufacturers:

a. ABB, Inc.

b. Atkore

c. American Conduit

d. Anamet Electrical, Inc.

e. Electri-Flex Co.

f. Hubbell (Fittings).

g. Nucor Tubular Products.

h. O-Z/Gedney Co.; Emerson.

i. Southwire Company, LLC

j. Western Tube and Conduit Corporation.

k. Wheatland Tube Co.

2. RMC:

a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.

1) Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.

b. RAC: ANSI C80.5, UL6A.

3. IMC: ANSI C80.6, UL 1242.

a. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.

4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.

a. Fittings: Compression type. Set Screw may be used in dry locations on conduits larger than 2-1/2".

5. FMC: Zinc-coated steel: UL 1. Reduced wall FMC is not allowed.

6. LFMC: Flexible steel raceway with PVC jacket: UL 360.

a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

a. ABB, Inc.

b. American Pipe and Plastics, Inc.

c. Anamet Electrical, Inc.

d. Atkore

e. Cantex Inc.

f. Carlon

g. Electri-Flex Co.

h. Hubbell Inc. (Fittings)

i. IPEX USA, LLC.

j. Prime Conduit.

k. Southwire Corporation.

l. Superflex Ltd.

2. RNC: Schedule 40 PVC: NEMA TC 2, UL 651.

a. Fittings: match to raceway and tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

2.2 BOXES, ENCLOSURES AND CABINETS

A. General

1. Manufacturers:
    a. ABB, Inc.
    b. American Midwest Power
    c. Appleton/O-Z Gedney Co.; Emerson.
    d. BEL Products, Inc.
    e. Cooper Crouse-Hinds; Eaton.
    f. Erickson Electrical Equipment Co.
    g. FSR, Inc.
    h. Hoffman.
    i. Hubbell, Inc.
    j. Legrand.
    k. Molex; Koch Industries.
    l. Robroy Industries, Inc.; Enclosure Division.
    m. Spring City Electrical Manufacturing Co.
2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.
    a. List and label as complying with UL 514A for non-hazardous locations;.
    b. List and label as complying with UL 886 for hazardous locations, where required.
3. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
4. Boxes for Ganged Devices: Use multi-gang boxes of single-piece construction. Do not use field-connected gangable boxes.
5. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

b. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

6. Do not use "through-wall" boxes designed for access from both sides of wall.

7. Wall Plates: Comply with Division 26 Section “Wiring Devices”.

C. Junction and Pull Boxes Larger Than 100 cubic inches:

1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.

2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.

3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

D. Cabinets and Enclosures:

1. General:

a. Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.

b. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes: Shall be keyed. Provide 2 keys for each enclosure.

1) All locks shall be keyed alike.

c. NEMA 250 Environment ratings:

1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.

2) NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.

d. Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.

e. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.

f. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring. Provide wire management troughs where practicable.

g. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.3 FACTORY FINISHES

A. Interior Finish: All interior components shall be factory finished; manufacturer's standard grey unless otherwise noted.

B. Exterior Finish: For metal enclosure or cabinet components, provide manufacturer's standard paint applied to factory-assembled enclosures and cabinets before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with manufacturer's instructions.

3.2 RACEWAYS

A. General

1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).
    a. 1/2-inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
    b. 3/8-inch flexible conduit may be used for light fixture whips.
3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
5. Install grounding bushings or other code compliant connections on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

10. Install raceways:

    a. To meet the requirements of the structure and the requirements of all other Work on the Project.

    b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

    c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.

    d. Parallel or perpendicular to building lines or column lines.

    e. Tight to structure.

    f. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

11. Raceways Embedded in Slabs:

    a. Raceways may only be embedded in concrete slabs with written permission from, and only where directed, by the Structural Engineer.

12. Where masonry, brick, CMU or concrete walls in occupied spaces are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.

13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section “Hangers and Supports for Electrical Systems”. Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.

    a. Raceways on roof shall be supported from structure not from the roof deck.

14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:

    a. Attach single raceway directly to structural steel with beam clamps.

    b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.

    c. Attach groups of raceways to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.

    d. Attach groups of raceways to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.

e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.

f. Hang horizontally suspended groups of raceways using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.

g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.

h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.

i. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.

15. Install electrically and physically continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.

16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.

17. Align and install raceway terminations true and plumb.

18. Complete raceway installation before starting conductor installation.

19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.

21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Contract Administrator, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Contract Administrator, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.

b. Where otherwise required by NFPA 70.

23. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment as required by other requirements of the construction documents.; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

24. Maintain 2" minimum spacing from bottom of roof deck to prevent raceway penetrations from above.

25. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.

26. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.

27. Install all underground conduits/raceways, outside the building footprint, a minimum of 24" below the bottom of paving/grade, unless noted otherwise, where practicable.

28. Where conduits are subject to earth movement by settlement or frost, provide expansion fittings to prevent damage to enclosed conductors or connected equipment.

29. Provide boxes and raceways for the fire protection system low voltage wiring as required. This includes low voltage wiring exposed less than 96" AFF.

    a. At a minimum, provide 3/4" conduit.

    b. Coordinate requirements and locations with system installer and fire alarm specifications.

B. RMC

1. Use GRS or IMC in the following areas:

    a. Where indicated.

    b. For Emergency Feeders.

    c. Exterior applications where above grade and exposed.

    d. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.

    e. Concealed within masonry walls.

    f. Damp or wet locations.

    g. Crawl spaces

    h. Interior spaces where exposed.

2. Use RAC in the following areas:

    a. Indoors above grade.

    b. Interior wet or damp locations.

3. Do not use RAC:

    a. Below grade.

    b. Imbedded in concrete or other areas corrosive to RAC.

C. EMT

1. Use EMT in the following areas:
    a. Where indicated.
    b. Interior concealed locations for:
        1) Branch circuits.
        2) Feeders.
        3) Emergency branch circuits.
        4) Low-voltage control, security, and fire alarm circuits
2. Do not use EMT:
    a. Below grade.
    b. In exterior applications when exposed.
    c. In interior applications when exposed in occupied areas.

D. FMC and LFMC
1. Use FMC or LFMC:
    a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
    b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
    c. Use FMC only in dry locations
    d. Use LFMC in damp, wet, corrosive, outdoor locations.
2. Do not use FMC or LFMC:
    a. For branch circuits, homeruns or feeders.
    b. In lengths exceeding 6 feet.

E. RNC
1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
2. Where installed in areas subject to temperature variations, install expansion fittings per NFPA 70, to accommodate thermal expansion in straight runs.
3. RNC is only allowed to be used in the following locations:
    a. Underground, single and grouped, in lieu of GRS or IMC, when indicated.
        1) Direct buried

F. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

3.3 RACEWAY FITTINGS:

A. Compatible with raceways and suitable for use and location.

B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.

C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.

D. Join raceways with fittings designed and approved for that purpose and make joints tight.

E. Use insulating bushings to protect conductors at raceway terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

3.4 BOXES:

A. General

1. Verify locations of device boxes prior to rough in.

2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.

3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.

4. Install boxes to preserve fire ratings of walls, floors, and ceilings.

5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.

6. Support boxes independently of raceway.

7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.

8. Adjust flush-mounted boxes to make front edges flush with finished wall material.

9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.

10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. NEMA Enclosure ratings, Suitable for the environment in which it is installed. At a minimum, provide the following ratings:

1. NEMA 250, type 3R

a. Provide at exterior locations

2. NEMA 250, type 1

a. Provide at interior and dry locations

C. Outlet Boxes

1. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.

2. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.

3. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes Use sheet-steel boxes for dry locations unless otherwise indicated or required.

4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.

6. Use cast aluminum boxes where aluminum rigid metal conduit is used.

7. Use suitable concrete type boxes where flush-mounted in concrete.

8. Use suitable masonry type boxes where flush-mounted in masonry walls.

9. Use raised covers suitable for the type of wall construction and device configuration where required.

10. Use shallow boxes where required by the type of wall construction.

11. Install extension and plaster rings as required by NFPA 70.

12. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.

13. Do not exceed allowable fill per NFPA 70.

14. Where multiple devices are shown grouped together, gang mount with a common cover plate.

D. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.

2. Provide boxes set flush in painted walls or ceilings with primer coated cover.

3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.

4. Boxes for exterior use shall be:

a. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.

b. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

3.5 CABINETS AND ENCLOSURES:

A. Unless otherwise indicated on the Drawings, provide

1. NEMA 1 construction for indoor, dry locations

2. NEMA 3R for outdoor locations

B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.

C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.

E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.

F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

3.6 IDENTIFICATION

A. Refer to Division 26 Section “Identification for Electrical Systems” for identification materials.

B. Raceway Identification:

1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Use the following means of identification:

a. Self-Adhesive Vinyl Labels

2. Color for Printed Legend:

a. Power Circuits: Black letters on an orange field.

b. Legend: Indicate system or service and voltage, if applicable

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:

1. Self-adhesive vinyl label

D. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.
4. Security System: Blue and yellow.
5. Mechanical and Electrical Supervisory System: Green and blue.
6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.

E. Underground Raceways Outside the Building Footprint: Bury warning tape approximately 18 inches above, parallel to raceway.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

G. Junction Boxes and Pull Boxes:

1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.
2. The junction box where a homerun ends and the circuit is distributed shall be marked. Junction boxes shall be marked approximately every 100 feet along homerun path to panel.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Raceways, fittings for underground electrical site distribution

B. Handholes and boxes

1.2 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit
4. RTRC: Reinforced Thermosetting Resin Conduit

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate layout and installation of raceways, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
2. Coordinate elevations of raceways entrances into handholes, and boxes with final locations and profiles of raceways 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 handholes, and as approved by the Contract Administrator.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:
   a. Raceways, Raceway fittings, handholes, boxes, and warning tape.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that Indicate dimensions from finished grade or other fixed structural elements.

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

2. Marked for intended use.

C. Comply with NFPA 70 and ANSI C2.

D. Non-concrete Handhold and Pull-Box Prototype Test: Test prototypes of boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.

B. Store factory–fabricated underground utility structures at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.

C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of existing electrical distribution systems:

1. Refer to Division 26 Section “General Electrical Requirements” for procedures regarding interruption of electrical systems.

PART 2 - PRODUCTS AND MATERIALS

2.1 RACEWAYS, FITTINGS AND DUCT ACCESSORIES

A. Metal Conduit

1. Manufacturers:

a. ABB, Inc.

b. American Conduit

c. Atkore

d. Nucor Tubular Products.

e. O-Z/Gedney Co.; Emerson.

f. Western Tube and Conduit Corporation.

g. Wheatland Tube Co.

2. RMC:

a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6

3. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.040 inches (1 mm), minimum.

4. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

a. ABB, Inc.

b. American Pipe and Plastics, Inc.

c. Anamet Electrical, Inc.;

d. Atkore

e. Cantex Inc.

f. Carlon

g. Champion Fiberglass, Inc.

h. Electri-Flex Co.

i. IPEX USA, LLC.

j. Prime Conduit.

k. Southwire Corporation.

l. Superflex Ltd.

m. United Fiberglass of America, Inc.

2. RNC: Schedule 40 PVC: NEMA TC 2, UL 651.

a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

3. RTRC: UL 2420 UG NEMA TC 14 SW (Standard Wall), HW (Heavy Wall) or XW (Extra Heavy Wall.)

C. Duct Accessories

1. Underground-line warning tape specified in Division 26 Section “Identification for Electrical Systems.”

2.2 HANDHOLES AND BOXES

A. General

1. Description: Comply with SCTE 77.

2. Color of Frame and Cover: Gray where installed in concrete or other paved area; Green where installed in grass area.

3. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.

4. Load Ratings:

a. Boxes and covers shall be rated for a design load of 15,000 lbs. minimum.

5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

7. Cover Legend: Molded lettering, applicable logo from the following:

a. "ELECTRIC"

8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pull-in irons.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armorcast Products Company.

b. Carson Industries LLC.

c. CDR Systems Corporation.

d. NewBasis.

e. Strongwell

PART 3 - EXECUTION

3.1 EXAMINATON

A. Receive and inspect premanufactured equipment.

B. Examine components before installation. Reject components that are damaged.

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

3.2 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.3 UNDERGROUND RACEWAY APPLICATION

A. Ducts for Electrical Feeders 600 volts and Less: RNC, NEMA Type EPC-40 PVC or RTRC SW or HW, in direct- buried duct bank, unless otherwise indicated.

B. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC or RTRC, in direct-buried duct bank, unless otherwise indicated.

3.4 UNDERGROUND ENCLOSURE INSTALLATION

A. Handholes and Boxes for 600 volts and Less,Including Communications, and Data Wiring:

1. Units in Driveway, Parking Lot, and Off-Roadway Locations: Polymer Concrete, SCTE 77, Tier 15 structural load rating.

3.5 EARTHWORK

A. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.

B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

C. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.6 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48-inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

E. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

F. Direct-Buried Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.

2. 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-inches 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 run and complete backfilling with normal compaction.

3. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts.

4. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.

5. Set elevation of bottom of duct bank below the frost line.

6. Install manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.

   b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.

7. Warning Tape: Bury warning tape approximately 18 inches above all duct banks. Align tape parallel to and within 3-inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional tapes 12-inches apart, horizontally.

3.7 INSTALLATION OF HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. For enclosures installed in concrete, asphalt and gravel dives form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box frame. Bottom of ring shall rest on compacted earth.

   1. Concrete: 3000psi, 28-day strength, complying with Division 03 Section “Cast-in-Place Concrete,” with a troweled finish.

   2. Dimensions: 10-inch wide by 12-inches deep

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

3.9 INSTALLATION ACCEPTANCE

A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wood test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct.

B. Clean internal surfaces of handholes and remove foreign materials.

END OF SECTION 260543

SECTION 260548 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. This section includes general seismic requirements specific other sections of the Division 26 specifications.

1.2 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 SUMMARY

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEPFTR Systems”.

B. The following equipment shall withstand the effects of earthquake motions. The equipment will remain in place without separation of any parts from the device when subjected to the seismic forces specified:

1. Panelboards used in normal power systems
2. Raceways and Boxes used in normal power systems
3. Low-Voltage Transformers used in normal power systems
4. Switchboards used in normal power systems
5. Panelboards used in normal power systems

C. In addition to the requirements above, the following equipment shall be fully operational after the seismic event:

1. Panelboards used in emergency power systems
2. Raceways and Boxes used in emergency power systems
3. Low-Voltage Transformers used in emergency power systems
4. Switchboards used in emergency power systems
5. Panelboards used in emergency power systems

1.4 SUBMITTALS

A. Provide submittals as required by Division 20 Section “Seismic Controls for MEPFTR Systems” for all electrical systems specified herein.

PART 2 - PRODUCTS AND MATERIALS
(Not Used)

PART 3 - EXECUTION
(Not used)

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Nameplates.
2. Labels for raceways.
3. Labels for junction boxes and pull boxes.
4. Labels for wiring devices.
5. Markers for conductors, and control cables.
6. Underground-line warning tape.
7. Warning labels and signs.
8. Arc Flash Warning Labels.
9. Miscellaneous identification products.
10. Painted Identification.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.

B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

C. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.3 SUBMITTALS

A. Product Data: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements” for each electrical identification product indicated:

1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Electrical Equipment, Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.

2. Marked for intended use.

B. Comply with ANSI A13.1 and ANSI C2.

C. Comply with requirements of NFPA 70.

D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Location, text, and method of identification to be used is noted in individual sections. Refer to other sections for additional identification requirements.

2.2 NAMEPLATES

A. Comply with UL RP 9691, Recommended Practice for Nameplates for Use in Electrical Installations.

B. Engraved, Laminated Acrylic or Melamine Label: Non-conductive phenolic with beveled edges.

1. Adhesive backed.

2. Minimum 1/16 inch (1.6 mm) thick for nameplates with both dimension 4 inches (102 mm) or less and 1/8 inch (3.2 mm) thick for larger sizes.

C. Text: Minimum text height shall be 1/8 inch (3.2 mm) unless otherwise required by local jurisdiction or owner standards. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

D. Colors:

1. Normal systems - white letters on a black background.

2. Emergency systems - white letters on a red background.

E. Label Requirements:

1. Service Equipment Label

LINE 1: NOMINAL VOLTAGE AND FREQUENCY IN HERTZ
LINE 2: SERVICE EQUIPMENT BUS RATING IN AMPS
LINE 3: SCCR OF SERVICE EQUIPMENT IN AMPS
LINE 4: MAXIMUM AVAILABLE FAULT CURRENT IN AMPS
LINE 5: DATE CALCULATED

EXAMPLE:

208Y/120V, 60HZ
800A
SCCR = 65,000A
MAX AVAILABLE FAULT CURRENT = 58,815A
CALCULATED: 01/01/2018

2. Panelboard/Switchboard Label:

LINE 1: PANELBOARD/SWITCHBOARD DESIGNATION
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM " "

EXAMPLES:

H1A
480Y/277V, 3PH, 4W, 200A
FED FROM MDB

L1A
208Y/120V, 3PH, 4W, 225A
FED FROM H1A VIA XFMR T1

3. Transformer Label:
LINE 1: TRANSFORMER DESIGNATION
LINE 2: FED FROM " "
LINE 3: SUPPLIES " "

EXAMPLE:

T1
FED FROM H1A
SUPPLIES L1A

4. Disconnect Switch Label:
LINE 1: DESIGNATION OF EQUIPMENT SERVED BY DISCONNECT
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM " "

EXAMPLES:

WATER HEATER WH1
480V, 3PH, 3W, 100A
FED FROM MDB

2.3 LABELS FOR RACEWAYS

A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 LABELS FOR JUNCTION BOXES AND PULL BOXES

A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.5 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

2.6 MARKERS FOR CONDUCTOR AND CONTROL CABLES

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

2.7 TAGS

A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.8 UNDERGROUND-LINE WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color: Tape for Buried Power Lines: Black text on red background.

2.9 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.

B. Self-Adhesive Warning Labels: Factory pre-printed or machine-printed multicolor self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

1. Use thermal transfer process printing machines and accessories recommended by label manufacturer.

2. Do not use labels designed to be completed using handwritten text.

2.10 ARC FLASH WARNING LABELS

A. General: All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system. Refer to Division 26 section “Power System Studies” for additional requirements.

B. Materials: Use machine-printed, high adhesion, polyester label; UV, chemical, water, heat, and abrasion resistant, for each work location analyzed.

C. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer. Labels shall be machine printed, with no field markings. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

D. Minimum Size: 3.5 inch by 5 inch (89 mm by 127 mm), unless otherwise noted by Owner.

E. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Available fault current
4. Limited approach boundary
5. Arc flash boundary
6. Restricted approach boundary
7. Hazard risk category
8. Incident energy
9. Working distance
10. Site-specific PPE (personnel protective equipment) requirements.
11. Date calculations were performed.
12. Engineering report number, revision number and issue date.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Fasteners for Nameplates, Labels and Signs

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

2.12 PAINTED IDENTIFICATION

A. Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior concrete and masonry primer.
      2) Finish Coats: Exterior semi-gloss acrylic enamel.
2. Exterior Concrete Unit Masonry:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Exterior semi-gloss acrylic enamel.
3. Exterior Ferrous Metal:
   a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior ferrous-metal primer.
      2) Finish Coats: Exterior semi-gloss alkyd enamel.
4. Exterior Zinc-Coated Metal (Except Raceways):
   a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior zinc-coated metal primer.
      2) Finish Coats: Exterior semi-gloss alkyd enamel.
5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
   a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior concrete and masonry primer.
      2) Finish Coats: Interior semi-gloss alkyd enamel.
6. Interior Concrete Unit Masonry:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Interior semi-gloss acrylic enamel.
7. Interior Gypsum Board:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior gypsum board primer.
      2) Finish Coats: Interior semi-gloss acrylic enamel.
8. Interior Ferrous Metal:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior ferrous-metal primer.
      2) Finish Coats: Interior semi-gloss acrylic enamel.
9. Interior Zinc-Coated Metal (Except Raceways):
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior zinc-coated metal primer.

2) Finish Coats: Interior semi-gloss acrylic enamel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify identity of each item before installing identification products.

B. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

C. Provide identification product listed for the location in which it is to be installed.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. For surfaces that require finish work, apply identification devices after completing finish work. Do not install identification products until final surface finishes and painting are complete.

C. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed. Replace labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

D. Location: Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance without interference with operation and maintenance of equipment. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

1. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

F. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.

1. Indoor Clean, Dry Locations: Use plastic nameplates, unless noted otherwise.

2. Outdoor Locations: Use plastic nameplates suitable for exterior use.

G. Install identification products centered, level, and parallel with lines of item being identified.

H. Mark all handwritten text, where permitted, to be neat and legible.

I. For refrigeration systems: Neatly bundle circuits and clearly tag and label each circuit with panelboard, branch circuit designation and refrigeration system number at each termination.

END OF SECTION 260553

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes computer-based studies for the following:

1. Short-circuit analysis.
2. Arc flash and shock risk assessment, including arc flash hazard labels.

B. Criteria for selection and adjustment of equipment and associated protective devices not specified in this section, as determined by the studies performed.

1.2 ADMINISTRATIVE REQUIREMENTS

A. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the short-circuit study. Device ratings for furnished equipment shall be as required by the results of the short-circuit study at no additional cost.

B. Coordination:

1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
3. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.

D. Sequencing:

1. Initial Study:
   a. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. Do not order equipment until matching study reports and product submittals have both been evaluated by the Contract Administrator.
   b. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the Contractor at no additional cost to the project.
2. Final Study:
   a. Study must be completed and submitted for review prior to substantial completion. Do not print arc flash labels until final study has been evaluated by the Contract Administrator.
   b. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels.

E. Scheduling:

1. Arrange access to existing facility for data collection with Owner.

2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner. Refer to Division 26 section “General Electrical Requirements” for additional requirements.

1.3 SUBMITTALS

A. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Product data for computer software program to be used for studies.

2. Include characteristic time-current trip curves for protective devices.

3. Include impedance data for busway.

4. Include impedance data for engine generators.

5. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

6. Include documentation of listed series ratings upon request.

7. Identify modifications made in accordance with studies to meet the results of the study.

B. Product Certificates: For Short-circuit-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data:

1. Study Preparer Specialist qualifications.

2. Field Testing Agency qualifications.

D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

E. Other Action Submittals:

1. Initial Study report, stamped or sealed and signed by study preparer, including:

a. Cover page including date of study, study methodology, assumptions made and software products used.

b. Study input data, including completed computer program input data sheets.

c. Short-circuit study report.

d. Equipment evaluation report.

e. Settings report.

2. Final Study report, stamped or sealed and signed by study preparer, including:

a. Cover page including date of study, study methodology, assumptions made, software products used, and summary of changes between initial and final studies.

b. Study input data, including completed computer program input data sheets.

c. Short circuit study report.

d. Equipment evaluation report.

e. Settings report.

f. Arc-Flash Hazard Analysis, including labels.

3. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.

2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

3. Include copies of previous studies and existing drawings that were obtained during the data collection phase of the study.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Study Preparer 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. Professional engineer, licensed in the state in which the Project is located, shall be responsible for the study and with a minimum five years experience in the preparation of studies of similar type and complexity using the specified computer software. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 399 for general study procedures.

D. Comply with IEEE 141, 242 and 551 for short-circuit currents and coordination time intervals.

E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.

F. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.

PART 2 - PRODUCTS AND MATERIALS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, use the latest commercially available computer software programs utilizing the specified methodologies developed by one of the following:

1. CYME International, Inc. (Eaton): *www.cyme.com.*
2. EasyPower – Part of Bentley Systems: *www.easypower.com.*
3. ETAP/Operation Technology, Inc: *etap.com.*
4. Power Analytics Corporation: *www.poweranalytics.com.*
5. SKM Systems Analysis, Inc: *www.skm.com.*

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of short-circuit-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 shall report device settings and ratings of all overcurrent protective devices.

1. Zero-Sequence current.
2. Arcing faults.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

B. Proceed with study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with study may not be used in study.

C. Short-circuit study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.

D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final short-circuit and coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity.

3.2 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths and operating modes on both sides of any transfer switch, contactor or circuit breaker.

B. Operating modes shall include, where applicable:

1. Utility as a source.
2. Generator as a source.
3. Maintenance settings.

C. Components include, but are not limited to:

1. Distribution Panelboards
2. Panelboards
3. Motor Controllers
4. Roof Top HVAC equipment

3.3 POWER SYSTEM DATA FOR STUDIES

A. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling. Gather and tabulate the following input data to support studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:
    a. Indicate load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    b. Protective Devices: Include circuit-breaker and fuse-current ratings and types;
    c. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
    d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio. kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    e. Generators: Include manufacturer/model, kilovolt amperes, size, voltage, and source impedance.
    f. Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length.

g. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.

h. Variable frequency drive rating, manufacturer, and model series.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Magnetic inrush current overload capabilities of transformers.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Ratings, types, and settings of utility company's overcurrent protective devices.

e. Special overcurrent protective device settings or types stipulated by utility company.

f. Protective Devices:

1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).

2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

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, motor-control center ampacity, and interrupting ratings in amperes rms symmetrical.

5. Existing Installations:

a. Provide the services of field testing agency or equipment manufacturer's representative to perform field data collection.

b. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.

3.4 SHORT-CIRCUIT STUDY

A. Source Impedance: Utility company's fault current contribution as provided by utility.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to

calculate values. Include studies of system-switching configurations and alternate operation modes that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.

E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
2. Low-Voltage Fuses: IEEE C37.46.
3. Circuit Breakers: IEEE C37.13.

F. Study Report:

1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
3. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.

G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing short-circuit current ratings of these devices with calculated short-circuit current momentary and interrupting duties. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3.5 ARC-FLASH HAZARD ANALYSIS

A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies in accordance with IEEE 1584. Perform the analysis under worst-case arc-flash conditions for all modes of operation.

B. In addition to the requirements outlined in IEEE 1584, the study shall include all equipment rated less than 240 Volts fed by transformers less than 125 kVA in the calculations.

1. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.
2. For single-phase systems, the calculations may be performed assuming a three-phase system in accordance with IEEE 1584, yielding conservative results.

C. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.

D. Identify all locations and equipment to be included in the arc-flash hazard analysis:

1. Include a copy of the facility one-line in the report.

2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.

3. Calculate the arcing fault current flowing through each branch for each fault location.

4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.

5. Select the working distances based on system voltage and equipment class.

6. Calculate the incident energy at each fault location at the prescribed working distance.

7. Determine the hazard/risk category (HRC) for the estimated incident energy.

8. Calculate the flash protection boundary at each fault location.

9. Document the assessment in reports and one-line diagrams.

10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.

E. Results of the arc-flash study shall be summarized in a final report containing the following:

1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.

2. Tabulations of the data used to model the system components and a corresponding one-line diagram.

3. Descriptions of the modes of operation evaluated and identification of the worst case scenario used to evaluate equipment ratings.

4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.

5. Required arc-flash labeling and placement of labels.

6. Conclusions and recommendations, including recommendations for reducing incident energy at locations where calculated maximum incident energy exceeds 8 calories per sq cm.

3.6 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

a. Verify that overcurrent protective devices meet parameters used in studies.

b. Adjust devices to values listed in final study results.

c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.7 INSTALLATION

A. Install arc flash warning labels. Refer to Division 26 section Identification for Electrical Systems for additional requirements.

3.8 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. Inspect and test protective devices in accordance with the NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Overcurrent protection devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies protective device settings have been adjusted in accordance with the requirements of the study. Include notation of conflicts with or deviations made from the studies or the contract documents, deficiencies detected, remedial action taken, and observations after remedial action.

3.9 TRAINING

A. Provide training for Owner’s personnel on electrical safety pertaining to arc flash and shock hazards.

B. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.

C. Provide minimum of eight hours of training performed by a representative of the entity performing the study.

END OF SECTION 260573

SECTION 261200 - MEDIUM VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following types of transformers with medium-voltage primaries:

1. Pad-mounted, liquid-filled transformers.

1.2 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

2. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 26 Section "General Electrical Requirements".

B. Product data: Include rated nameplate data, capacities, weights, dimensions, colors, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

1. Medium-voltage Transformers.

C. Coordination Drawings: Floor and site plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Underground primary and secondary conduit stub-up location.

2. Dimensioned concrete base, outline of transformer, and required clearances.

3. Ground rod and grounding cable locations.

D. Seismic Qualification Certification: For each medium voltage transformer, accessories, components, from manufacturer.

1. Certificate of compliance.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

H. Follow-up service reports.

I. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.28.

D. Comply with IEEE C57.12.70.

E. Comply with NFPA 70.

F. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Meet requirements for usual service conditions described in IEEE C57.12.00 and for the specified unusual service conditions.

1. Maximum Ambient Temperature: 104 degrees F(40 degrees C.)
2. Altitude: Below 3300 feet above sea level.
3. Load Current Harmonic Factor: 0.05 per unit, maximum.

1.7 QUALIFICATIONS

A. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.

B. Materials shall be manufactured by Companies specializing in the products specified in this section with minimum 3 years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

B. Coordinate delivery of equipment to allow movement into designated space.

C. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

D. Handle and prepare transformers according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.9 INTERRUPTION OF EXISTING ELECTRICAL DISTRIBUTION SYSTEMS:

A. Refer to Division 26 Section “General Electrical Requirements” for procedures regarding interruption of electrical systems.

1.10 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of transformers that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

1.11 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

PART 2 - PRODUCTS AND MATERIALS

2.1 PAD-MOUNTED, THREE-PHASE, LIQUID-FILLED TRANSFORMERS

A. Manufacturers:

1. ABB Inc.
2. Eaton Corporation
3. Maddox Industrial Transformer.
4. Pioneer Transformers.
5. Schneider Electric.
6. Siemens Industry, Inc.
7. Uptegraff, R. E. Mfg. Co.
8. Virginia Transformer Corp.

B. Description: IEEE C57.12.00, pad-mounted, 2-winding transformers. Stainless-steel tank base.

1. Additional standards: Comply with IEEE C57.12.26.
2. Windings: Aluminum

C. Insulating Liquid:

1. Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.

2. Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

D. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

E. Basic Impulse Levels (BIL):

1. 95 kV for 15 kV class.

F. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

G. High-Voltage Terminations and Equipment: Dead-front.

H. Bushings:

1. High-Voltage Dead-Front Bushings:

a. 200 A Bushings: Universal wells or one-piece integrated for use with separable connectors; externally clamped and front-removable.

2. Low-Voltage Bushings:

a. Molded polymer, provided with blade-type spade terminals with NEMA standard hole spacing arranged for vertical take-off.

b. Provide low-voltage neutral insulated bushing, grounded to tank by removable ground strap.

I. Wye-Wye Transformers: Provide high neutral internally connected to low-voltage neutral with provisions for opening connection.

J. Switches:

1. Provide load-break, gang-operated, liquid-immersed switch, externally operable from high-voltage compartment with distribution hot-stick.

K. Switch Type: [4-position sectionalizing for extended-radial or loop-feed system with feed-from-left, feed-from-right, isolated-from-either side, or through-fee to both sides].

L. Switch Rating: 200 A.

M. Fusible Protection:

1. Provide Bay-O-Net liquid-immersed fuses in series with oil-immersed, current-limiting fuses; Bay-O-Net fuses to be externally replaceable with hot-stick without opening transformer tank.

N. Accessories:

1. Drain Valve: 1 inch (25 mm), with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Mounting provisions for low-voltage potential transformers.
8. Busway terminal connection at low-voltage compartment.
9. Alarm contacts for gages and thermometer listed above.

2.2 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to federal law 10 CFR Part 431 and IEEE C57.12.90, including:

1. Ratio.
2. Polarity.
3. Phase rotation.
4. No-load loss.
5. Excitation current.
6. Impedance voltage.
7. Load loss.
8. Applied potential.
9. Induced potential.
10. QC impulse test.
11. Leak test.
12. Temperature test. Typical test data from previous testing may be used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install transformers on concrete bases. Comply with requirements for equipment bases and foundations in Division 26 Section "Hangers and Supports for Electrical Systems."

1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Seismic Controls for Electrical Systems."

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions, NFPA 70, and the local utility companies.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical System."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Reconnect existing load break elbows to new medium-voltage transformer bushings.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.

2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Test Reports: Prepare written reports to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

3. Adjust transformer taps.

4. Prepare written request for voltage adjustment by electric utility.

5. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.

6. Report: Prepare written report covering monitoring and corrective actions performed.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 261200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes panelboards rated 600 V and less, including the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and Overcurrent Protective Devices.
4. Surge Protection Devices.

1.2 DEFINITIONS

A. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

B. SVR: Suppressed voltage rating.

C. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Initial Fault-Current Study, must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies.”

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of panelboard, switching and overcurrent protective device, furnished accessories and components. Include dimensions and Manufacturer’s technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
    a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
2. Detail enclosure types and details for other than NEMA 250, Type 1.
3. Include general arrangement drawing showing dimensions and weights of each assembled section.
4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
5. Detail short-circuit current rating of panelboard assembly and overcurrent protective devices.
6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include schematic and wiring diagrams for power, signal, and control wiring.
9. Include nameplate legends.
10. Include list of materials.

D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around panelboards where pipe and ducts are prohibited. Show panelboard layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
2. Dimensioned concrete base, outline of panelboard sections, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.
3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.
4. Location of structural supports for structure-supported raceways, and seismic bracing.
5. Location and clearance of electrical equipment and raceways impacting equipment installation.

E. Seismic Qualification Data: For panelboard equipment, accessories, and components, from manufacturer.
1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Qualification Data: For qualified testing agency.

G. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

H. Manufacturer's field service report.

I. Sample Warranty: For warranty.

J. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

K. Panelboard Schedules: Submit final panelboard directories.

L. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for panelboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

4. Features and operating sequences, both automatic and manual.

M. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperature: minus 14 deg F (minus 26 deg C) to plus 109 deg F (plus 43 deg C)..
2. Altitude not exceeding 6600 feet (2000 m).
3. Humidity: 99%.

C. Interruption of Existing Electric Service: Do not interrupt electric service to occupied facilities. Refer to Division 26 Section “General Electrical Requirements” for allowable outages.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of equipment to allow movement into designated space.

B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

C. Handle and prepare panelboards for installation according to NEMA PB 1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the panelboards that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

1.9 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Refer to Division 26 section “Fuses” for spare fuse requirements. At a minimum, include spares for the following:
    a. Fuses for fusible devices.
    b. Potential transformer fuses.

c. Control power fuses.

2. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).

3. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. ABB Inc.

2. Eaton.

3. Schneider Electric.

4. Siemens Energy & Automation, Inc.

B. Enclosures: Flush- or surface-mounted cabinets as noted.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.

2. Hinged Front Cover: Entire front trim hinged to box.

3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.

4. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and/or bottom as required.

D. Buses: Three phase, four wire unless otherwise indicated.

1. Phase, and Neutral Buses:

a. Material:

1) Tin-plated aluminum.

a) Hard-drawn copper, 98 percent conductivity,may be substituted if provided at no additional cost.

b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard’s sections.

1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit

neutral cables. Brace bus extensions for busway feeder neutral bus

2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

   a. Material: Hard-drawn copper, 98 percent conductivity

   b. Size: Minimum-size required by UL 67

3. Provide any available breaker mounting space with bussing.

E. Line-Side Conductor Connectors (Lugs):

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.

2. Material: Same as bus material.

3. Capacity rating: Same as associated bus.

4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.

5. Provide properly sized lugs for all equipment, circuit breakers and other electrical devices to accommodate installed conductors. A larger frame, oversized lugs or non-standard product may be required in some instances.

   a. Pin adapters may be utilized only as allowed by manufacturer and the authority having jurisdiction.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Short-Circuit Current Rating (SCCR):

1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section “Power System Studies”.

2. Rating value: Rated to withstand symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in panelboard.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

C. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Megawatts: Plus or minus 2 percent.

e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

2. Remote Monitoring: Onboard webpage server available via BACnet-IP with event logging and a minimum storage of one-year of historical demand data.

a. Coordinate meter setup and remote monitoring gateway configuration with controls contractor to achive full monitoring compatibility over controls network.

3. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

D. Mains: As indicated on drawings.

E. Branch Overcurrent Protective Devices:

1. Connection to bus:

a. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

b. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2. Type: Provide types as indicated on drawings and as defined below.

F. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.

2. Voltage and frequency rating: same as panelboard.

3. Short-circuit current rating (SCCR): Same as requirements for panelboard.

4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: As indicated on drawings.

C. Branch Overcurrent Protective Devices:

1. Connection to bus: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2. Type: Provide types as indicated on drawings and as defined below.

D. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.

2. Voltage and frequency rating: same as panelboard.

3. Short-circuit current rating (SCCR): Same as requirements for panelboard.

4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Arc Flash Mitigation

1. Circuit breakers, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.

2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.5 SURGE PROTECTION DEVICES

A. Provide surge protective devices as required by Division 26 Section “Surge Protective Devices”.

B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.6 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine panelboards before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive panelboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.

2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1 and manufacturer’s instructions.

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

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

E. Floor-Mounted Panelboards: Install panelboards on concrete bases.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of panelboards unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

2. Anchor panelboards to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Seismic Controls for Electrical Systems."

3.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to panelboards.

6. Attach panelboards to the vertical finished or structural surface behind the panelboards.

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

G. Mount top of trim 72 inches (1788 mm)above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Install overcurrent protective devices and controllers not already factory installed.

J. Install fuses in fusible devices.

K. Install filler plates in unused spaces.

L. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

M. Comply with NECA 1.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Equipment Nameplates: Label each contiguous main, or entrance section with equipment nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

D. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.

E. Panel Directories

1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
2. Note the date the directory was created/updated.
3. Create directory after loads have been balanced to reflect actual as-built conditions.
4. Circuit descriptions shall be per code and shall be distinguishable from all others.
5. Replace existing directories with revised type written directories indicating changes.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Power System Studies."

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control tests and inspections:

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

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

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Receptacles:

1. Ground fault current interrupter type (GFCI)

B. Wall Plates and Covers

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. IG: Isolated Ground

C. TR: Tamper Resistant

D. USB: Universal Serial Bus

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
3. Notify Contract Administrator of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".

B. Product Data:

1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, and cover plates.

C. Field quality-control test reports.

D. Warranty: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.

B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.

2. Marked for intended use.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

B. Wiring Device Finishes:

1. Provide wiring device finishes as described below, unless otherwise indicated.

2. Wiring devices connected to normal power systems: Gray, unless otherwise indicated or required by NFPA 70. Cover plates: stainless steel.

3. Material for cover plates in unfinished spaces and for surface mounted wiring devices: Galvanized steel.

2.2 RECEPTACLES

A. Manufacturers:

1. Receptacles and Switches:

a. Eaton.

b. Hubbell Incorporated.

c. Legrand.

d. Leviton.

B. Receptacles - General Requirements: Self-grounding, impact-resistant nylon face, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring with separate ground terminal screw.

2. NEMA configurations specified are according to NEMA WD 6.

C. The basis-of-design catalog numbers listed below are generally for 20A rated duplex devices.

D. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

a. Provide test and reset buttons of same color as device.

Type - Duplex GFCI	Specification Grade	Hospital Grade
Weather-Resistant GFCI	Legrand 2097TRWR	Legrand 2097HGTRWR
Weather-Resistant/Tamper-Resistant GFCI	Legrand 2097TRWR	Legrand 2097HGTRWR

2.3 WALL PLATES AND COVERS

A. Wall Plates: Comply with UL 514D.

1. Match corresponding wiring devices and manufacturer of wiring devices specified herein.

2. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.

3. Size: Standard unless otherwise indicated.

4. Screws: Metal with slotted tamper-resistant heads finished to match wall plate finish.

B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

C. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

D. Weatherproof Receptacle Covers for Wet or Damp Locations: Gasketed, cast aluminum with hinged lockable cover for vertical mounting and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type. (Covers listed are single-gang for GFCI device, 2-gang or other device similar.) Back box must be suitable for conduit connections. Coordinate back box with wall depth.

Weatherproof cover for Wet Location In-Use	Cast Aluminum
Vertical	Hubbell WP26E

PART 3 - EXECUTION

3.1 GENERAL

A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Contract Administrator.

B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.

3.2 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring

E. Verify that conditions are satisfactory for installation prior to starting work.

3.3 PREPARATION

A. If required, provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.4 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.

C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box.

E. Install switches with OFF position down.

F. Install cover plates on all switches, receptacles, and blank outlets.

G. Locate wiring devices so that the cover plate does not have to be cut to be installed.

H. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

I. Install cover plates after the wall has been finished (painted, wall paper, etc).

J. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

K. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but

are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6' or sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.

L. Install wiring devices shown back-to-back on a common wall offset a minimum of 12" horizontally to reduce sound transmission between rooms.

3.5 MOUNTING HEIGHTS AND ORIENTATION

A. Coordinate locations of outlet boxes provided under Division 26 Section "Common Work Results for Electrical".

B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.

1. Receptacles:

a. General:

1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.

2) Where Installed horizontally, install neutral slot mounted at the top.

b. Mechanical and electrical equipment rooms and janitors closets:

1) Mount vertically.

c. Weatherproof exterior receptacles:

1) Mount vertically.

d. GFCI receptacles: Same as general receptacles.

e. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.

3.6 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:

a. Durable wire markers or tags inside outlet boxes.

b. Permanent-ink marker, hand-printed legibly, inside outlet boxes.

B. Label all devices fed down stream of GFCI protected receptacles as "GFCI PROTECTED".

3.7 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

D. Test all wiring devices for electrical continuity and proper polarity of connections.

E. Test each GFCI receptacle device for proper operation.

F. Correct wiring devices incorrectly installed.

G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.8 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.9 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cartridge Fuses

B. Accessories

1. Fuseholders
2. Fuse Reducers

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed and with system short-circuit current levels.
3. Coordinate location of and access to spare fuse cabinet(s) with final electrical equipment layouts within electrical equipment rooms.
4. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Initial Fault-Current Study report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies.”

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, and descriptions of individual components.

1. Include the following for each fuse type indicated:
   a. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      1) For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      2) Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   b. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. All items requested under “Product Data”.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Comply with NEMA FU 1 for cartridge fuses.

E. Comply with NFPA 70.

F. Comply with UL 248.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

2.2 MANUFACTURERS

A. Manufacturers:

1. Bussmann, a division of Eaton Corporation; www.cooperindustries.com.

2. Littelfuse, Inc.; www.littelfuse.com.

3. Mersen; ep-us.mersen.com.

4. Edison Fuse, Inc; www.edisonfuses.net.

2.3 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.4 ACCESSORIES

A. Provide the following accessories where indicated or where required to complete installation:

1. Fuseholders: Compatible with indicated fuses.

2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

B. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install in accordance with manufacturer's instructions.

C. Install fuses in fusible devices. Arrange fuses so manufacturer, type and rating information is readable without removing fuse.

3.3 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Feeders:

a. Greater than 600A:

1) Class L, time delay

b. 600A or less:

1) Class RK1, time delay

2. Motor Branch Circuits:

a. Class RK1 time delay

3. Other Branch Circuits:

a. Class RK1, time delay

4. Control Circuits:

a. Class CC fast acting

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fusible switches.

B. Non-fusible switches.

C. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of enclosed switches and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Initial Fault-Current Study report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies”.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of enclosed switch, accessory, and component indicated. Include dimensions and Manufacturer’s technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.

C. Shop Drawings: For enclosed switches.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

    a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for other than NEMA 250, Type 1.

3. Include general arrangement drawing showing dimensions and weights of each assembled section.

4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.

5. Detail short-circuit current rating of enclosed switch assembly and overcurrent protective devices.

6. Include descriptive documentation of barriers specified for electrical insulation and isolation.

7. Include schematic and wiring diagrams for power, signal, and control wiring.

8. Include nameplate legends.

9. Include list of materials.

D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed switches where pipe and ducts are prohibited. Show enclosed switch layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Seismic Qualification Certificates: For enclosed switches, accessories, and components, from manufacturer.

1. Certificate of compliance.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Sample Warranty: For warranty.

H. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

I. Operation and Maintenance Data: For enclosed switches to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed switches and all installed components.

2. Manufacturer's written instructions for testing and adjusting enclosed switches.

3. Time-current curves; include selectable ranges for each type of overcurrent protective device.

4. Features and operating sequences, both automatic and manual.

5. Video recording of operation training and demonstration.

J. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

B. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install enclosed switches until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

b. Altitude: Not exceeding 6600 feet (2010 m).

C. Interruption of Existing Electric Service: Refer to Division 26 section “General Electrical Requirements”

1.7 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of equipment to allow movement into designated space.

B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

C. Handle and prepare enclosed switches components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

1.9 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section "Seismic Controls for Electrical Systems" and Division 20 Section "Seismic Controls for MEP/F/T Systems".

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Primary Switch Contact Lubricant: One container.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Short Circuit Current Rating: 100,000 rms symmetrical amps when fuses applied.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

2.4 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine enclosed switches before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive enclosed switches with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

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

3.2 INSTALLATION

A. Install enclosed switches and accessories in accordance with manufacturer's instructions.

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

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Wall-Mounted Switches: Install enclosed switches on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

E. Mount equipment plumb and rigid without distortion of enclosure.

F. Install fuses in fusible devices.

G. Comply with NECA 1.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Equipment Nameplates: Label each section with equipment nameplate.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control tests and inspections:

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each enclosed switch, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
4. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

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

END OF SECTION 262816

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes field or factory-mounted Surge Protective Devices (SPDs) for low-voltage (120 to 600 V) power distribution and control equipment, including:

1. Surge Protection Devices at Service Entrance Equipment
2. Surge Protection Devices at Branch Panelboards

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. I*n* or I*nominal*: Nominal Discharge Current. Peak value of surge current, selected by the manufacturer, through the SPD having current wave shape of 8/20 microseconds where the SPD remains functional after 15 surges. I*n* is posted on the device UL label.

C. MCOV: Maximum Continuous Operating Voltage. The maximum continuous operating voltage rating of a Metal Oxide Varistor (MOV) that can be applied without the MOV being damaged and/or destroyed by thermal runaway. MCOV is posted on the device UL label.

D. SCCR: Short Circuit Current Rating. The maximum current rating the SPD can sustain without being damaged and/or destroyed. SCCR is posted on the device UL label.

E. SPD: Surge Protective Device. A broad class of protective devices, installed parallel with the distribution panel or service disconnect, meant to protect downstream electrical distribution equipment from the effects of high voltage surges on the line.

F. SPD Type definitions:

1. TYPE 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch circuit panel.

G. VPR: Voltage Protection Rating. The average of measured limiting voltage before and after Nominal Discharge Testing (In), rounded up to one of UL's VPR categories (indicated in the latest ANSI/UL 1449 edition) such as 330 volt, 400 volt, 500 volt, etc. VPR is posted on each device UL label.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."

B. Coordinate layout and installation of SPDs and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.

C. Fault-Current Study report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Overcurrent Protective Device Coordination Study”.

D. Do not energize or connect any electrical or low voltage equipment to their sources until SPDs are installed and connected.

E. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each SPD type, accessory, component and enclosure indicated. Include dimensions and Manufacturer’s technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes. Tabulate model number, SPD type, system voltage, phases, modes of protection, MCOV, VPR, and I_n.

C. Shop Drawings: For SPDs.

1. Detail enclosure types and details.
2. Include general arrangement drawing showing dimensions and weights of each assembled device.
3. Include installation and mounting details for SPDs internal to equipment.
4. Detail bus connection configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus.
5. Detail short-circuit current rating of SPD assembly and overcurrent protective devices.
6. Include schematic and wiring diagrams for power, signal, and control wiring.
7. Include nameplate legends.
8. Include list of materials.

D. Product Certificates: For SPDs, from manufacturer.

E. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Sample Warranty: For warranty.

G. Project Record Documents: Record actual installed equipment and circuiting arrangements.

H. Operation and Maintenance Data: For SPDs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for SPDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting SPDs.
3. Time-current curves for each type of overcurrent protective device.
4. Features and operating sequences, both automatic and manual.

I. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

B. Source Limitations: Obtain SPDs of each type and associated components and accessories through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

D. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

E. Comply with NEMA LS 1.

F. Comply with NFPA 70.

G. The SPDs shall be compliant with the restrictions of the Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not install SPDs until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above equipment. Provide temporary HVAC system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
    b. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
    c. Humidity: 0 to 85 percent, noncondensing.

d. Altitude: Less than 20,000 feet (6090 m) above sea level.

C. Interruption of Existing Electrical Service: Refer to Division 26, Section “General Electrical Requirements”.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish.

B. Handle and prepare SPD components according to manufacturer's written instructions.

1.8 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. ABB USA.
2. Eaton.
3. Intermatic, Inc.
4. LEA International.
5. Leviton Mfg. Company Inc.
6. Siemens.
7. Schneider Electric.
8. Surge Suppression Incorporated.
9. Vertiv.

B. Surge Protective Device Ratings: Device type ratings shall be:

1. Type 2 - Service entrance equipment or distribution equipment

C. Nominal System Voltage: Match the system voltage to which the SPD is connected, as indicated on the drawings.

D. Maximum Continuous Operating Voltage: Not less than 125 percent of nominal system voltage for 240V or less power systems, and not less than 115 percent of nominal system voltage for 600V and 480V power systems.

E. Comply with ANSI/UL 1449.

F. SPDs for Lightning Protection: For Lightning Protection Systems specified or otherwise required to be "Master Labeled" per UL 96A utilize Type 1 (20kA rated I_n) SPDs.

2.2 SURGE PROTECTION DEVICES AT SERVICE ENTRANCE EQUIPMENT

A. Surge Protection Devices: Integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
5. LED indicator lights for power and protection status.
6. Six-digit transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 2 SPD's shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V
Line to Neutral	1200	700
Line to Ground	1200	700
Neutral to Ground	1200	700

2.3 SURGE PROTECTION DEVICES AT BRANCH PANELBOARDS

A. Surge Protection Device: Integrally mounted, wired-in, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.

4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

5. LED indicator lights for power and protection status.

6. Six-digit, transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 2 SPD's shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V
Line to Neutral	1200	700
Line to Ground	1200	700
Neutral to Ground	1200	700

2.4 ENCLOSURES

A. All SPD Units shall be fully enclosed unless otherwise noted. Provide enclosures suitable for the locations indicated and as described below:

1. Indoor Enclosures:

a. NEMA 250 Type 1 constructed of a polymer or steel material

2. Outdoor Enclosures:

a. NEMA 250 Type 3R constructed of steel material and with a gasket to exclude dirt, windblown dust, and water (rain, sleet, and snow) from entering the enclosure when shut.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surge suppression devices before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive SPDs with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.

2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.

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

3.2 INSTALLATION

A. Install SPDs and accessories in accordance with manufacturer's instructions.

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

C. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

D. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

E. Mount equipment plumb and rigid without distortion of enclosure.

F. Install fuses in fusible devices.

G. Comply with NECA 1.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Nameplates: Label external device enclosures with equipment served.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

C. Warning Labels: Label device with a warning label in accordance with NFPA 70 and NFPA 70E.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control tests and inspections:

B. Acceptance Testing Preparation:

1. After installing SPD but before equipment is energized, test for compliance with requirements.
2. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
3. Complete startup checks according to manufacturer's written instructions.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 264313

SECTION 284600 - FIRE DETECTION AND ALARM

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. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 26 Section "Common Work Results for Electrical," for materials and methods for coordination, sleeves and common installation requirements.

1.2 DESCRIPTION OF WORK

A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.

B. Division 28 of the Specifications and Drawings numbered with prefixes FA generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. The scope of work in this section includes:

1. Fire alarm control unit
2. Remote annunciator
3. Manual fire alarm pull stations
4. System smoke detectors
5. Heat detectors
6. Sprinkler system waterflow and valve tamper alarms
7. Air handling unit shutdown

1.3 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.4 APPLICABLE CODES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.

1. NFPA 70, "National Electrical Code", 2017 Edition.
2. NFPA 72, "National Fire Alarm and Signaling Code", 2019 Edition.
3. NFPA 101, "Life Safety Code", 2018 Edition.
4. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
5. International Building Code (IBC) 2018 Edition with local amendments.

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.5 DEFINITIONS

A. General:

1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”

2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”

3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.”

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. FACP: Fire Alarm Control Panel.

9. NICET: National Institute for Certification in Engineering Technologies.

10. VESDA: Very Early Smoke-Detection Apparatus.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.6 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.

C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.

F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:

1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.
2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector’s housing.
3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.
4. Conduit shall be by Division 26 “Common Work Results for Electrical”.

G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.7 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.

B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.

C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.

D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.

E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.

F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless the Contractor has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.

J. Shop Drawings:

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

2. Shop drawings shall be prepared by a NICET Level 3 or higher certified technician. Submit copies of the certification for the designer with submittal.

3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.

4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).

5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.

6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.

7. Include voltage drop calculations for notification-appliance circuits.

8. Include battery-size calculations.

9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than 3/32" = 1'-0".

10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.

K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.

L. Qualification Data: Submit copies of the certification for the Installer.

M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for Substitutions.

B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.

D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.

B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:

1. Typewritten Index.
2. Qualifications. Provide designer and installer qualification.
3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
5. Product Data: Provide product cutsheets for all equipment utilized and installed.
6. Riser diagram.
7. Device addresses.
8. Record copy of site-specific software.
9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
    a. Equipment tested.
    b. Frequency of testing of installed components.

c. Frequency of inspection of installed components.

d. Requirements and recommendations related to results of maintenance.

e. Manufacturer's user training manuals.

10. Manufacturer's required maintenance related to system warranty requirements.

11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.

12. Guarantee. Copy of all guarantees and warranties issued.

13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.

B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.

C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.

D. Refer to Division 1 and General Conditions for Record Drawings

E. At the completion of the project, the Contractor shall obtain at their expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Architect/Engineer.

1.13 SPARE PARTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide 10% of the total or a minimum of one (1) manual pull station.

2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.

3. Provide 5% of the total or a minimum of one (1) of each type of automatic heat detector.

4. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.

5. Provide 5% of the total or a minimum of two (2) of each horn/speaker type. Combination horn/speaker/strobe units matching the units installed are acceptable.

6. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.

B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.

C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.

D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

A. Refer to Division 1 and General Conditions for Guarantees and Warranties.

B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.

C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.

D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.

E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

1.16 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting a bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Fire Alarm Contractor shall perform the demolition which involves fire alarm system equipment and materials.
4. Fire Alarm Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall be removed from the premises and disposed of in accordance with applicable federal, state and local regulations.

5. Fire Alarm Contractor shall relocate and reconnect fire alarm equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. General Contractor shall install finish material.

6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

7. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

8. Locate, identify, and protect Fire alarm services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

C. Interruption of Existing Fire alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire watch service according to local Fire Department requirements:

1. Notify Architect no fewer than seven days in advance of proposed interruption of fire alarm service.

2. Do not proceed with interruption of fire alarm service without Architect's written permission.

D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.17 SEQUENCING AND SCHEDULING

A. Existing Fire alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire alarm system, remove all unused fire alarm equipment, wiring and installation materials not necessary for system functionality or spare parts.

PART 2 - PRODUCTS AND MATERIALS

2.1 SYSTEM DESCRIPTION

A. Noncoded ,UL-listed > addressable system, with multiplexed signal transmission and voice strobe evacuation.

B. All components provided shall be listed for use with the selected system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.2 MANUFACTURER

A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:

1. Potter

2.3 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual pull stations.
2. Heat detectors.
3. Smoke detectors.
4. Automatic sprinkler system water flow.

B. Fire alarm signal shall initiate the following actions:

1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).
    a. A pulsing alarm tone shall occur within the control panel until acknowledged.
    b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.
2. Transmit an alarm signal to the alarm supervising station.
3. The audible and visible alarm signal shall operate until it is manually silenced or acknowledged.
4. Record events in the system memory.
5. Activate voice/alarm communication system.
6. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate smoke-control system (smoke management).
9. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Duct-smoke detectors
3. User disabling of zones or individual devices.
4. Loss of communication with any panel on the network.

D. System Supervisory Signal Actions:

1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
    a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
    b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
2. Record events in the system memory.
3. After a time delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
4. Transmit system status to building management system.
5. Display system status on graphic annunciator.
6. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke ,report to BAS system and remain down until manually reset.
7. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire alarm control unit.
5. Ground or a single break in internal circuits of fire alarm control unit.
6. Abnormal ac voltage at fire alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire alarm control unit or annunciator.
10. Voice signal amplifier failure.

F. System Trouble Signal Actions:

1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).
    a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
    b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
2. Record events in the system memory.
3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.
4. Transmit system status to building management system.
5. Display system status on graphic annunciator.

2.4 FIRE ALARM SYSTEM CONTROL UNIT

A. General Requirements for Fire alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
    f. The control unit shall have dedicated alarm, supervisory and trouble LED’s and dedicated alarm, supervisory and trouble acknowledge, and alarm silence switches.
    g. Lamp Test: Manual lamp test function causes each LED to function at fire alarm control panel.
    h. Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.
    i. The FACP shall be provided with surge protection.
    j. Install in a surface mounted enclosure.
    k. The fire alarm system control unit shall be UL listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, <80> characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. The location of the dedicated branch circuit disconnecting means shall be permanently identified at the control unit.

2. The circuit disconnecting means shall have a red marking and be provided with a breaker lock or other approved method to avoid accidental operation.

3. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

D. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead acid.

2. The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 15 minutes.

E. System Supervision: Automatically detects and reports open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification appliance circuits. Alarm, supervisory and trouble signals shall be monitored by the supervising station over a Digital Alarm Communicator Transmitter (DACT), or other approved method.

2.5 EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEMS (EVACS):

A. The system shall incorporate one-way emergency voice communication via specified speakers. A central audible module shall provide for the necessary alarm message/tone generation, main and remote microphone connections and mixers/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure (main microphone trouble, tone trouble, etc.)

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.

b. Programmable tone and message sequence selection.

c. Standard digitally recorded messages for "Evacuation" and "All Clear."

d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire alarm control unit.

2. Hand held push to talk, noise canceling microphone in recessed protective panel mounted enclosure; 5 feet coiled cable; and LED to indicate the microphone push to talk has been pressed.

3. Audible power amplifiers shall be self filtered; contain 24 volt power supply, transformer and amplifier monitor circuits; Amplifier shall operate all system speakers plus twenty-five (25) percent spare capacity.

4. Digitized voice messages are required to notify building occupants during alarm conditions. Message player shall not rely on tape or mechanical means of transmitting the voice message. A standard evacuation message shall be provided; however, the system shall be capable of transmitting a custom message of up to five (5) minutes long.

5. Alarm sequence shall consist of a temporal (3) alarm tone for a maximum of 15 seconds followed by an automatic pre-selected message. At the end of the message the tone shall resume. This sequence shall continue until the fire alarm control panel has been silenced. Manual voice paging shall be available via panel switches to page individual floors or groups of floors. Each floor shall be an individual audible zone and have a corresponding audible switch.

2.6 GRAPHIC ANNUNCIATOR

A. Graphic Annunciator Panel: Mounted in an aluminum frame with non-glare, minimum 3/16-inch- thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.

2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.

3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.

4. Surface mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.

5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot scale or larger.

B. Graphic Annunciator Workstation: PC with operating system software, minimum 21 inch digital display monitor, keyboard and mouse. The system shall incorporate a PC with fire alarm annunciator software including historical logging, report generation, and a graphic interface showing all alarm points in the system.

2.7 INITIATING DEVICES

A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible

indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
2. Station Reset: Key or wrench operated switch.
3. Indoor Protective Shield: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.

1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer’s standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.

1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
5. Provide remote alarm LEDs and remote test stations as shown on the plans.
6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

D. Heat Detectors – Comply with UL 521. Detector shall have twist lock base interchangeable with smoke detectors bases and be equipped with an integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.

1. Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

2. Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 deg F (88 deg C).

E. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.

2. Provide strobe synchronization as required per NFPA 72.

3. Wall mounted notification appliances shall be manufacturer standard red finish.

4. Ceiling mounted notification appliances shall be manufacturer standard red finish.

F. Exterior Alarm Bells: Electric vibrating, 10-inch bell with operating mechanism behind dome and weatherproof bell kit. Sound Rating: 90 dB at 10 feet.

G. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated ¼ to 2 watts and produce 79 to 88 dB at 10 feet.

2.8 AUXILIARY DEVICES

A. Waterflow Alarm Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer. Switch shall have an adjustable delay to minimize false alarms due to fluctuations in water pressure.

B. Valve (Tamper) Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer.

C. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.

D. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form “C” dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

E. Fire Department Key Box: Shall be by Knox Company or as otherwise specified by the authority having jurisdiction. Provide internal switch(es), as required by the Authority Having Jurisdiction, to indicate supervisory condition(s) at the fire alarm control and annunciator panels.

2.9 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for smoke detectors, notification appliances, or other device requiring protection as indicated on the plans.

1. Factory fabricated and furnished by device manufacturer.

2. Finish: Factory finished to match the color of the protected appliance or device.

2.10 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.

B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.

C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.

D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.

E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.

F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

G. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

H. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

I. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.

1. Initiating Device Circuits: Match existing circuits.
   a. Pathway Survivability: < Level 2.
2. Notification Appliance Circuits: Match existing circuits.
   a. Pathway Survivability: Level 0
3. Signaling Line Circuits: Match existing circuits.
   a. Pathway Survivability: Level 0
4. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.

2.11 ACCESS TO EQUIPMENT

A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings.

2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

3. Access doors must be of the proper materials for type of construction where installed.

4. The exact location of all access doors shall be verified with the Architect prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

   a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.

   b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

   a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.

9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

10. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

    a. Arrow United Industries.

    b. Bar-Co., Inc.

    c. J.L Industries.

    d. Karp Associates, Inc.

    e. Milcor Div. Inryco, Inc.

    f. Nystrom Building Products

g. Wade

h. Zurn

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install, program and test all new equipment identified in this contract and revise existing equipment as noted in accordance with the applicable codes, standards, and manufacturer's instructions.

B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.

C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.2 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.3 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.

2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel.

2. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing functions to the new points. New components shall be

capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

D. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.

E. Smoke and Heat Detectors: Provide detectors as shown on drawings.

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat detector spacing.
3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
5. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
6. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.

F. Duct Smoke Detectors: Comply with NFPA 72Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.
2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.

G. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.

H. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.

I. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.

J. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.

K. All notification appliance speakers shall be tapped at ½ watt unless noted otherwise on drawings. In rooms less than 100 sq ft, speakers are permitted to be tapped at ¼ watt.

3.4 PATHWAYS

A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.

1. Exposed pathways located less than 96 inches above the floor shall be installed in conduit.

B. Pathways shall be installed in conduit.

C. All detection and control circuits associated with smoke control systems shall be fully enclosed within continuous raceways.

D. Minimum allowable conduit size shall be ¾ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

E. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.

F. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.

G. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.

H. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.

I. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.5 CONNECTIONS

A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm initiating connection to smoke control system (smoke management) at firefighters' smoke control system panel.

2. Smoke dampers in air ducts of designated HVAC systems.

3. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.

3.6 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).

C. The location of end-of-line resistors shall be identified with a label indicating “EOL.”

D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

3.8 GROUNDING

A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.

1. Smoke detectors shall be tested with products of combustion.

B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.

C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner’s designated personnel. Test

in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:

1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    a. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
    b. Test visible appliances for the public operating mode according to manufacturer's written instructions.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire alarm system will be considered defective if it does not pass tests and inspections.

F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor’s factory-trained technicians.

3.10 DEMONSTRATION

A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.

B. Demonstrate normal and abnormal modes of operation, and required responses to each.

C. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

END OF SECTION 284600

APPENDIX 1

Calculation Package for
Fulton Center HVAC Improvements

August 28, 2026

Prepared for

Missouri DOC

Prepared by

Walter P. Moore and Associates, Inc.
1100 Walnut Street, Suite 1825
Kansas City, MO 64106

Walter P Moore Project No.
D08.24014.00

Table of Contents

Governing codes 2
Load determination 3
Roof Load Take-off 4
ASCE Hazard Report 5
Snow Loads 8
Wind Loads 9
Earthquake Loads 10
Check of Existing Roof Joists 11
Critical Joist Building D 12
Critical Joist Building L 17
Critical Joist Building B 22
Check of HVAC support rails 30
Check of Ladder attachment to CMU wall 42
Anchor to wall face 43
Design of Lintel above new opening in Building K 57

Governing Codes

Calculations in this package follow the requirement of the 2015 International Existing Building code (IEBC) with city of Fulton, MO Amendments. The following referenced codes were used for design.

- ASCE 7-10: “Minimum Design Loads and Associated Criteria for Buildings and other Structures”
- AISC 360-10: “Specification for Structural Steel Buildings”

LOAD DETERMINATION

Roof Load Take-off

Building B (Gymnasium) and High roof of Housing Units (Bldgs D-M)

Building B		
16 GA x 1 1/2" metal deck	3.5	psf
3" rigid insulation	2.4	psf
5/8" gypboard	2.5	psf
EPDM membrane w/ ballast	15	psf
Ductwork allowance	4	psf
TOTAL	27.4	psf
DEAD LOAD (ROUNDED)	**28**	**psf**

From Record drawings, Phase 2

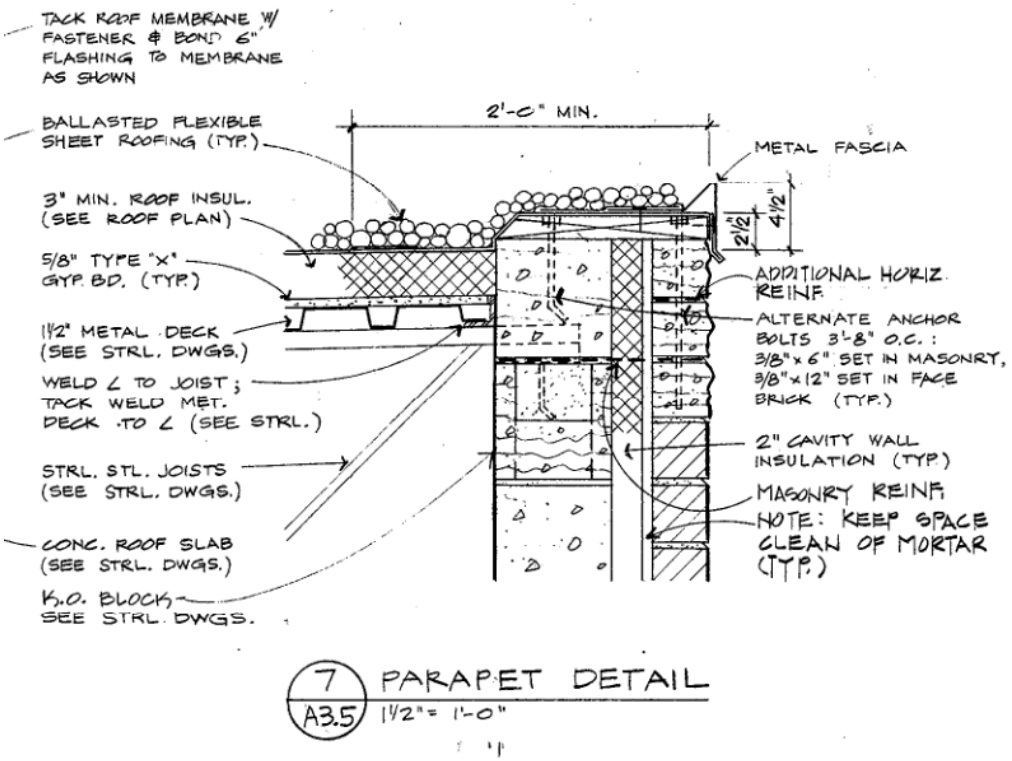


Figure 1. Typical roofing – Building B and High roof in Housing Units

ASCE Hazard Report

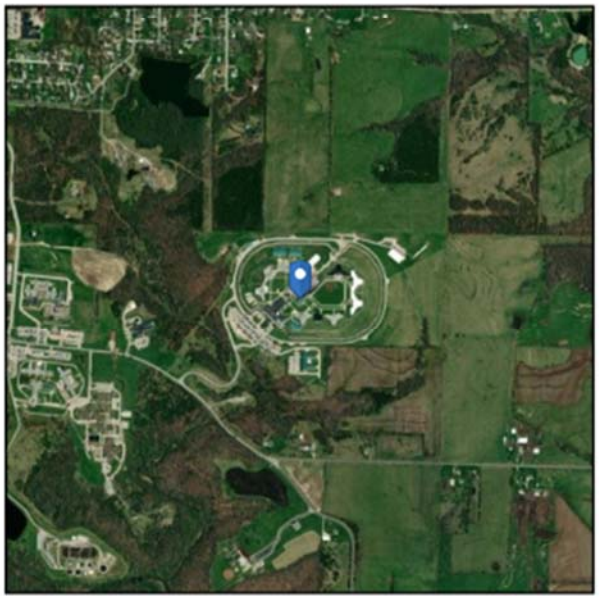
Following is the detailed output from ASCE's hazard tool website for the project location:

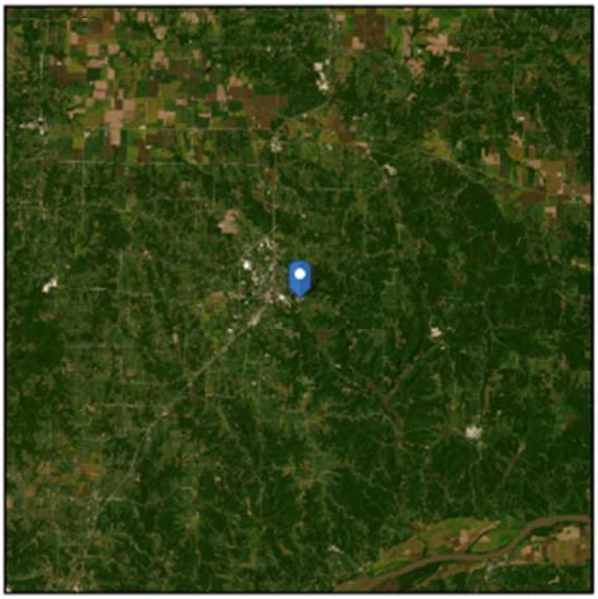
ASCE Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-10
Risk Category: III
Soil Class: D - Stiff Soil

Latitude: 38.845709
Longitude: -91.922637
Elevation: 795.2081128777611 ft (NAVD 88)





Wind

Results:

Wind Speed	120 Vmph
10-year MRI	76 Vmph
25-year MRI	84 Vmph
50-year MRI	90 Vmph
100-year MRI	96 Vmph

Data Source: ASCE/SEI 7-10, Fig. 26.5-1B and Figs. CC-1–CC-4, and Section 26.5.2, incorporating errata of March 12, 2014
Date Accessed: Wed Jun 05 2024

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-10 Standard. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (annual exceedance probability = 0.000588, MRI = 1,700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-10 Section 26.2.

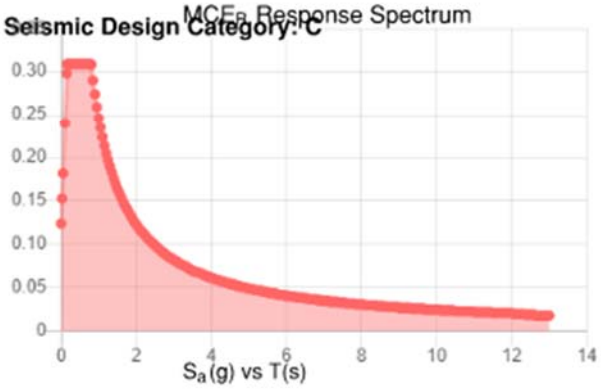
Seismic

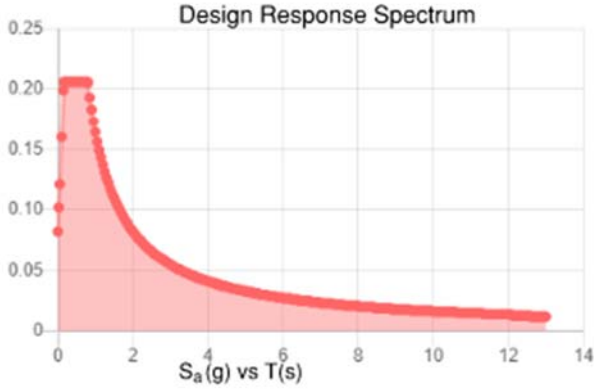
Site Soil Class: D - Stiff Soil

Results:

S_S :	0.193	S_{D1} :	0.164
S_1 :	0.103	T_L :	12
F_a :	1.6	PGA :	0.092
F_v :	2.387	PGA_M :	0.148
S_{MS} :	0.309	F_{PGA} :	1.6
S_{M1} :	0.246	I_e :	1.25
S_{DS} :	0.206		

Seismic Design Category: C





Data Accessed: Wed Jun 05 2024

Date Source:
USGS Seismic Design Maps based on ASCE/SEI 7-10, incorporating Supplement 1 and errata of March 31, 2013, and ASCE/SEI 7-10 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-10 Ch. 21 are available from USGS.

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

Ice

Results:

Ice Thickness:	1.00 in.
Concurrent Temperature:	5 F
Gust Speed	40 mph
Data Source:	Standard ASCE/SEI 7-10, Figs. 10-2 through 10-8
Date Accessed:	Wed Jun 05 2024

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain with concurrent 3-second gust speeds, for a 50-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Snow

Results:

Ground Snow Load, p_g :	20 lb/ft^2
Mapped Elevation:	795.2 ft
Data Source:	ASCE/SEI 7-10, Fig. 7-1.
Date Accessed:	Wed Jun 05 2024

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported 'elevation' and 'mapped elevation' differ significantly from each other.

Snow Loads

JOB NAME:	Fulton Center HVAC Improvements		
JOB NO.:	D08.24014-00	DATE:	
ENGINEER:	RC	DWG. REF.:	XX
TAG NO.:		SHEET NO.:	XX

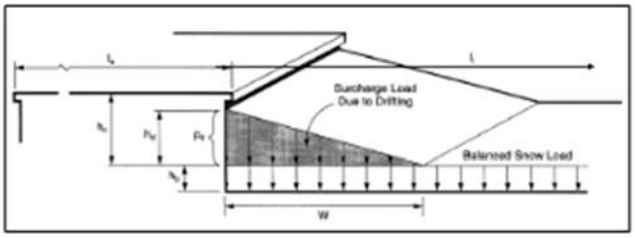
FLAT ROOF SNOW LOAD CALCULATIONS

Description: This spreadsheet calculates the flat roof snow loads, p_f, snow drift loads and widths, p_d and W, and sliding snow loads.

Design Code: ASCE 7-10

Ground Snow Information:

p_g =	20.0	psf
C_e =	1.0	
C_t =	1.0	
I =	1.1	



Configuration of Snow Drifts on Lower Roofs

Snow Load Calculations:

p_f =	15.4	psf
p_{min} =	22.0	psf
γ =	16.6	pcf
h_b =	0.9277	ft

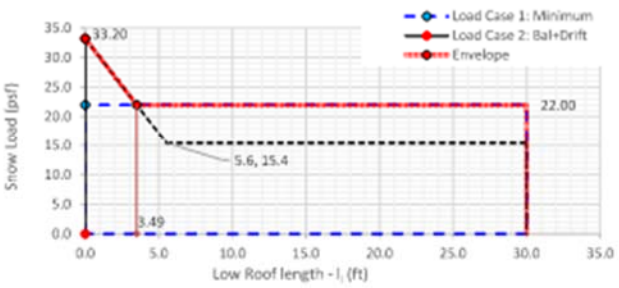
Snow Drift Calculations:

Location	Roof or Parapet?	h (ft)	l_u (ft)	l_l (ft)	h_c (ft)	h_d (ft) (Leeward)	h_d (ft) (Windward)	h_d (ft) (Used)	W (ft)	p_d (psf)	
Equipment	Parapet	2	30	30	1.07	N/A	1.22	1.07	**5.55**	**17.8**	

Sliding Snow Calculations:

Location	Ridge-Weave Dist (ft)	p_s (psf)
Vault Roof	18	**7.39**

Plot Snow Drift Diagram for: **Equipment**



Snow Drift Diagram

Notes:

1. The minimum snow load is a separate load case. It need not be used in determining or in combination with drift, sliding, unbalaced snow loads
2. An envelope as shown in the plot (shaded portion) can be used to simplify snow load application. However, engineer needs to ensure that this will not lead to overly conservative designs.

Components and Cladding Wind Pressures - ASCE 7-10 (Flat, Gable, or Hip Roofs)

Design Method: ASCE 7-10

Building Classification:

ASCE 7-10 Basic Wind Speed, V:	120	mph
Exposure Category (B, C, D):	C	
α:	9.50	
z_g:	900	
Topographic factor, K_{zt}:	1.00	
Wind directionality factor, K_d:	0.85	
Internal pressure coefficient, $+GC_{pi}$:	0.18	
Internal pressure coefficient, $-GC_{pi}$:	-0.18	

Building Characteristics:

Angle of roof from horizontal, θ:	1.5	deg
Eave height, h:	22	ft
Least horizontal dimension:	40	ft
Parapet Height	2	ft
Max top of parapet elevation:	24	ft
Hip roof (Y or N)?	N	

Calculated Values:

Velocity pressure coeff. at h, K_h:	0.92	
Velocity pressure at h, q_h:	28.8	psf
Velocity press. coeff. at parapet, K_p:	0.94	
Velocity pressure at parapet, q_p:	29.4	psf
Width of pressure coeff. zone, a:	4.0	ft

Rooftop Equipment Pressures (h<60 ft):

GCr (lateral):	1.9	
GCr (uplift):	1.5	
Lateral pressure:	+/-54.8	psf
Uplift pressure:	43.2	psf

Cladding Type	Location	Effective Area (sf)	Coefficients +GCp	Coefficients -GCp	Wind pressures +p (psf)	Wind pressures -p (psf)
Wall	Interior	10	0.90	-0.99	+31.1	-33.7
		20	0.85	-0.94	+29.8	-32.4
		50	0.79	-0.88	+27.9	-30.5
		100	0.74	-0.83	+26.6	-29.2
		500	0.63	-0.72	+23.4	-25.9
Wall	Edge	10	0.90	-1.26	+31.1	-41.5
		20	0.85	-1.16	+29.8	-38.8
		50	0.79	-1.04	+27.9	-35.1
		100	0.74	-0.94	+26.6	-32.4
		500	0.63	-0.72	+23.4	-25.9
Roof	Interior	10	0.30	-1.00	+16.0	-34.0
		20	0.27	-0.97	+16.0	-33.2
		50	0.23	-0.93	+16.0	-32.0
		100	0.20	-0.90	+16.0	-31.1
		500	0.20	-0.90	+16.0	-31.1
Roof	Edge (Parapet<3ft)	10	0.30	-1.80	+16.0	-57.1
		20	0.27	-1.59	+16.0	-51.0
		50	0.23	-1.31	+16.0	-43.0
		100	0.20	-1.10	+16.0	-36.9
		500	0.20	-1.10	+16.0	-36.9
Roof	Corner (Parapet<3ft)	10	0.30	-2.80	+16.0	-85.9
		20	0.27	-2.29	+16.0	-71.2
		50	0.23	-1.61	+16.0	-51.7
		100	0.20	-1.10	+16.0	-36.9
		500	0.20	-1.10	+16.0	-36.9

Cladding Type	Location	Effective Area (sf)	Coefficients +GCp	Coefficients -GCp	Wind pressures +p (psf)	Wind pressures -p (psf)
Overhang	Interior	10	0.00	-1.70	+16.0	-54.2
		20	0.00	-1.67	+16.0	-53.3
		50	0.00	-1.63	+16.0	-52.2
		100	0.00	-1.60	+16.0	-51.3
		500	0.00	-1.10	+16.0	-36.9
Overhang	Edge (Parapet<3ft)	10	0.00	-1.70	+16.0	-54.2
		20	0.00	-1.67	+16.0	-53.3
		50	0.00	-1.63	+16.0	-52.2
		100	0.00	-1.60	+16.0	-51.3
		500	0.00	-1.10	+16.0	-36.9
Overhang	Corner (Parapet<3ft)	10	0.00	-2.80	+16.0	-85.9
		20	0.00	-2.20	+16.0	-68.6
		50	0.00	-1.40	+16.0	-45.6
		100	0.00	-0.80	+16.0	-28.3
		500	0.00	-0.80	+16.0	-28.3
Parapet	Interior	10	2.70	-1.89	+79.3	-55.5
		20	2.44	-1.79	+71.7	-52.7
		50	2.10	-1.67	+61.7	-49.0
		100	1.84	-1.57	+54.1	-46.2
		500	1.73	-1.35	+50.8	-39.6
Parapet	Edge (Parapet<3ft)	10	3.70	-2.16	+108.7	-63.4
		20	3.14	-2.02	+92.2	-59.2
		50	2.40	-1.83	+70.5	-53.6
		100	1.84	-1.68	+54.1	-49.4
		500	1.73	-1.35	+50.8	-39.6

Notes:

1. Positive pressures signify pressures acting toward the surface.
2. Positve wall pressures shown are calculated based on z = h. At lower elevations, windward pressures may be lower.
3. Negative pressures signify pressures acting away from the surface.
4. This spreadsheet is only valid for enclosed and partially enclosed buildings.
5. **Roof pressures are only valid for flat, gable, and hip roofs.**
6. No internal pressures are included for parapets because they cancel each other out.

Earthquake Loads

JOB NAME:	Fulton Center C		
JOB NO.:	D08.24014.00	DATE:	8/27/2026
ENGINEER:	RC	DWG. REF.:	
TAB NO.:		SHEET NO.:	

Seismic Design Forces on Nonstructural Components and Anchorage Forces

Description: Rooftop HVAC Unist

Input Variables:

Code =	ASCE 7-16		
a_p =	2.50		Component amplification factor per ASCE 7-16 Table 13.5-1 or 13.6-1
R_p =	6.00		Component response modification factor per ASCE 7-16 Table 13.5-1 or 13.6-1
I_p =	1.00		Component importance factor per ASCE 7-16 section 13.1.3
S_{DS} =	0.21		Short-period design spectral response acceleration parameter per ASCE 7-16 section 11.4.4
W_p =	1507.0	lbs	Component operating weight
z =	22.0	ft	Component point of attachment elevation with respect to the base
h =	22.0	ft	Supporting structure average roof height relative to the base
Ω_O =	2.50		Overstrength factor per ASCE 7-16 Table 13.5-1 or 13.6-1

The horizontal seismic design force on Nonstructural components:

F_p =	155.2	lbs	per ASCE 7-16, Eqn 13.3-1	$F_p = 0.4 a_p S_{DS} W_p (1 + 2\,z/h)/(R_p/I_p)$
≤	496.7	lbs	maximum, per ASCE 7-16 equation 13.3-2	$F_{p,max} = 1.6 S_{DS} I_p W_p$
≥	93.1	lbs	minimum, per ASCE 7-16 equation 13.3-3	$F_{p,min} = 0.3 S_{DS} I_p W_p$

Therefore,

F_p =	**155.2**	lbs	(= **0.10** x W_p)
$F_{p,anc}$ =	**155.2**	lbs	

For Concurrent Vertical Force: **F_v = ± 62.1 lbs** $F_v = \pm 0.2 S_{DS} W_p$

Consider 100/30 Rule for Anchorage Forces: No

Lateral load due to seismic loads at 155 lbs. is significantly less than the corresponding horizontal load due to wind loads for the same equipment (F_{WL} = 1,930 lbs.), thus wind loads control the design.

CHECK OF EXISTING ROOF JOISTS

Check of critical roof joist on Building D

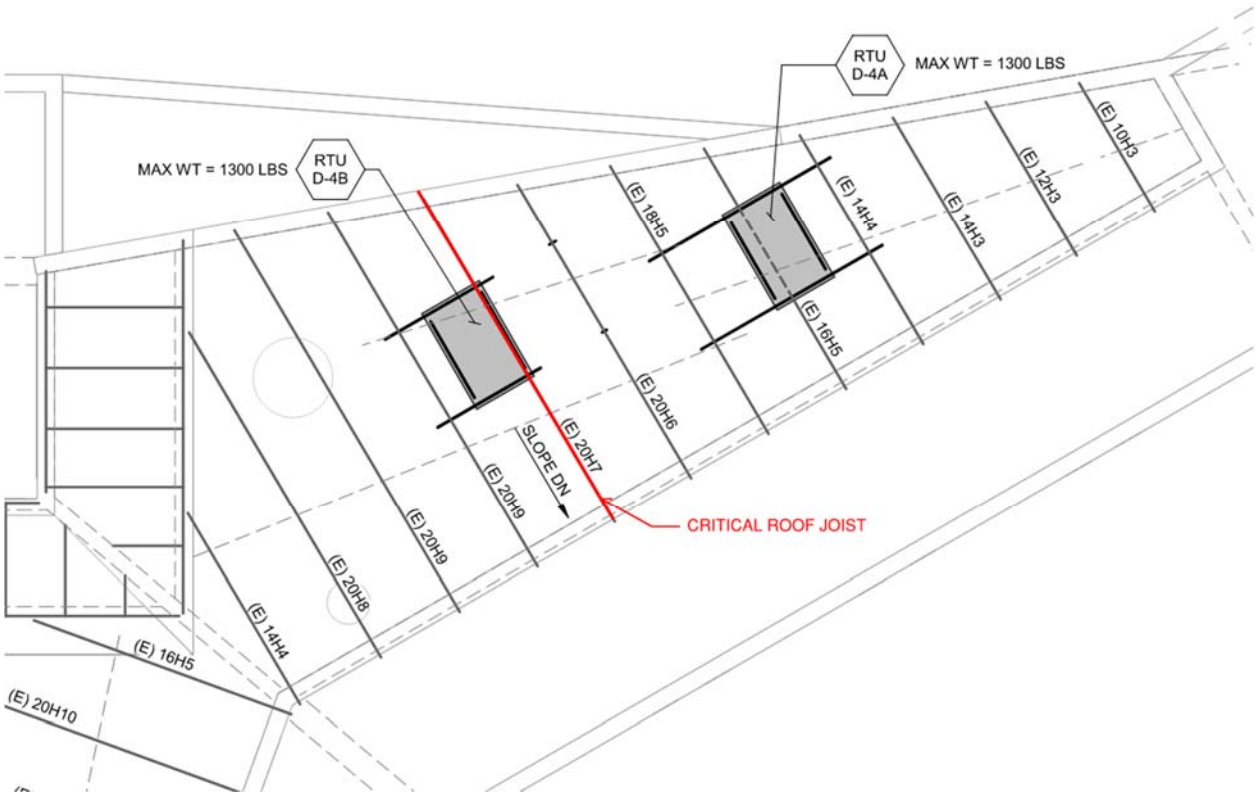


Figure 2. Critical roof joist on Building D

See MathCad calculation in following pages

Calculation Description: Spreadsheet to calculate the load demand and compare with allowable loads of open web roof joists with the addition of the HVAC units . Joist Capacity is calculated per SJI Historical Load Tables

Limitations: HVAC unit is assumed to span perpendicular to roof joists. Wind load is applied to the long face of the equipment. ASD Load combinations using Dead, Live roof, snow, and horizontal wind loads are assumed.

Input and Notes:

1. Input values are highlighted in yellow
2. Reference documents like architectural roofing detail and SJI load table are included at the end of this spreasheet

---

Joist Properties

Joist selection $\begin{bmatrix} w_{OWJ} \\ V_a \\ M_a \\ S_{jst} \end{bmatrix} :=$ Joist Name: 20H7

See building roof plan and SJI Historical Load Table

Jost spacing $S_{spcg} := 6\ ft$

See building roof plan

Joist weight $w_{OWJ} = 10.7\ plf$

Allowable shear $V_a = 5400\ lbf$

Allowable Moment $M_a = 499\ kip \cdot in$

Joist Span $S_{jst} = 25.75\ ft$

Load Demands

Roof dead load $\omega_{rf} := 28\ psf$

Distributed roof live load $\omega_{Lr} := 20\ psf$

Snow load $\omega_s := 22\ psf$

See snow load calculation spreadsheet (conservative)

Wind Load on roof (down) $\omega_{Wdn} := 16\ psf$

HVAC Properties

Weight includes HVAC unit, curb and steel members spanning between roof joists

Consider joist supports up to 2 HVAC units

$\begin{bmatrix} W_{HVAC.1} \\ H_{HVAC.1} \\ L_{HVAC.1} \\ B_{HVAC.1} \\ x_{1.HVAC.1} \\ x_{2.HVAC.1} \end{bmatrix} :=$ HVAC Unit: D4B

$\begin{bmatrix} W_{HVAC.2} \\ H_{HVAC.2} \\ L_{HVAC.2} \\ B_{HVAC.2} \\ x_{1.HVAC.2} \\ x_{2.HVAC.2} \end{bmatrix} :=$ HVAC Unit: None

Weight of HVAC Unit	$W_{HVAC.1} = 1300\ lbf$	$W_{HVAC.2} = 0\ lbf$
HVAC unit dimensions	$H_{HVAC.1} = 51.0\ in$	$H_{HVAC.2} = 53.750\ in$
	$L_{HVAC.1} = 88.1\ in$	$L_{HVAC.2} = 74.000\ in$
	$B_{HVAC.1} = 53.3\ in$	$B_{HVAC.2} = 48.000\ in$
	$x_{1.HVAC.1} = 7.500\ ft$	$x_{1.HVAC.2} = 12.000\ ft$
	$x_{2.HVAC.1} = 15.000\ ft$	$x_{2.HVAC.2} = 15.000\ ft$

Curb height $H_{curb} := 24\ in$

Lateral wind pressure $p_{WL} := 54.8\ psf$ *Conservative*

Load Calculations: Equipment is assumed to span parallel to roof joists and wind load applied on long face of equipment

Distributed dead load from HVAC weight

$$w_{DL.1} := \frac{W_{HVAC.1}}{2 \cdot L_{HVAC.1}} \qquad w_{DL.1} = 88.5\ \frac{lbf}{ft}$$

$$w_{DL.2} := \frac{W_{HVAC.2}}{2 \cdot L_{HVAC.2}} \qquad w_{DL.2} = 0.0\ \frac{lbf}{ft}$$

Overturning moment due to wind load on equipment

$$M_{WL.HVAC.1} := p_{WL} \cdot L_{HVAC.1} \cdot \frac{\left(H_{HVAC.1} + H_{curb}\right)^2}{2} \qquad M_{WL.HVAC.1} = 7858\ lbf \cdot ft$$

$$M_{WL.HVAC.2} := \text{if}\left(W_{HVAC.2} = 0\ ,0\ lbf \cdot ft\ , p_{WL} \cdot L_{HVAC.2} \cdot \frac{\left(H_{HVAC.2} + H_{curb}\right)^2}{2}\right) \qquad M_{WL.HVAC.2} = 0\ lbf \cdot ft$$

Distributed force couple on roof joist due to wind load on equipment

$$w_{WL.HVAC.1} := \frac{M_{WL.HVAC.1}}{S_{spcg} \cdot L_{HVAC.1}} \qquad w_{WL.HVAC.1} = 178\ \frac{lbf}{ft}$$

$$w_{WL.HVAC.2} := \text{if}\left(W_{HVAC.2} = 0\ ,0\ \frac{lbf}{ft}\ , \frac{M_{WL.HVAC.2}}{S_{spcg} \cdot L_{HVAC.2}}\right) \qquad w_{WL.HVAC.2} = 0\ \frac{lbf}{ft}$$

Total distributed dead load on roof joist per linear foot $w_{DL} := w_{OWJ} + S_{spcg} \cdot \omega_{rf}$ $w_{DL} = 178.7\ plf$

Total distributed live roof load on roof joist (per linear foot) $w_{Lr} := \omega_{Lr} \cdot S_{spcg}$ $w_{Lr} = 120.0\ plf$

Total distributed snow load on roof joist (per linear foot) $w_S := \omega_S \cdot S_{spcg}$ $w_S = 132.0\ plf$

Total distributed wind load downward on roof joist (per linear foot) $w_{Wdn} := \omega_{Wdn} \cdot S_{spcg}$ $w_{Wdn} = 96.000\ plf$

Moment and shear demands from distributed loads

$$M_{dist}\left(x, w\right) := \frac{w}{2} \cdot x \cdot \left(S_{jst} - x\right)$$

$$V_{dist}\left(x, w\right) := w \cdot \left(\frac{S_{jst}}{2} - x\right)$$

Base reaction force due to distributed load on partial length of joist

$$R_1\left(w, x_1, x_2\right) := w \cdot \frac{\left(x_2 - x_1\right)}{S_{jst}} \cdot \left(S_{jst} - \frac{\left(x_1 + x_2\right)}{2}\right)$$

Roof joist base Reaction due to point loads

$$R_2\left(w, x_1, x_2\right) := w \cdot \left(x_2 - x_1\right) \cdot \frac{\left(x_1 + x_2\right)}{2 \cdot S_{jst}}$$

Moment due to distributed load on partial length of joist

$$M_{dist.ptl}(x, w, x_1, x_2) := \begin{cases} \text{if } x \geq 0 \text{ in} \wedge x \leq x_1 \\ \quad R_1(w, x_1, x_2) \cdot x \\ \text{else if } x \leq x_2 \\ \quad R_1(w, x_1, x_2) \cdot x - w \cdot \dfrac{(x - x_1)^2}{2} \\ \text{else if } x \leq S_{jst} \\ \quad R_2(w, x_1, x_2) \cdot (S_{jst} - x) \end{cases}$$

$$V_{dist.ptl}(x, w, x_1, x_2) := \begin{cases} \text{if } x \geq 0 \text{ in} \wedge x \leq x_1 \\ \quad R_1(w, x_1, x_2) \\ \text{else if } x \leq x_2 \\ \quad R_1(w, x_1, x_2) - w \cdot (x - x_1) \\ \text{else if } x \leq S_{jst} \\ \quad -R_2(w, x_1, x_2) \end{cases}$$

Defining 100 discrete points along roof joist

$$i := 0 .. 100 \qquad x_{0_i} := \frac{i}{100} \cdot S_{jst}$$

Moment due to DL

$$M_{DL_i} := M_{dist}(x_{0_i}, w_{DL}) + M_{dist.ptl}(x_{0_i}, w_{DL.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + M_{dist.ptl}(x_{0_i}, w_{DL.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Shear due to DL

$$V_{DL_i} := V_{dist}(x_{0_i}, w_{DL}) + V_{dist.ptl}(x_{0_i}, w_{DL.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + V_{dist.ptl}(x_{0_i}, w_{DL.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Moment due to live load

$$M_{Lr_i} := M_{dist}(x_{0_i}, w_{Lr})$$

Shear due to live load

$$V_{Lr_i} := V_{dist}(x_{0_i}, w_{Lr})$$

Moment due to snow load

$$M_{S_i} := M_{dist}(x_{0_i}, w_S)$$

Shear due to snow load

$$V_{S_i} := V_{dist}(x_{0_i}, w_S)$$

Moment due to Wind

$$M_{WL_i} := M_{dist}(x_{0_i}, w_{Wdn}) + M_{dist.ptl}(x_{0_i}, w_{WL.HVAC.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + M_{dist.ptl}(x_{0_i}, w_{WL.HVAC.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Horizontal wind load on equipment

Shear due to Wind

$$V_{WL_i} := V_{dist}(x_{0_i}, w_{Wdn}) + V_{dist.ptl}(x_{0_i}, w_{WL.HVAC.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + V_{dist.ptl}(x_{0_i}, w_{WL.HVAC.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Load combination factors

$$\gamma_{DL} := \begin{bmatrix} 1.0 \\ 1.0 \\ 1.0 \\ 1.0 \end{bmatrix} \qquad \gamma_{Lr} := \begin{bmatrix} 0 \\ 1.0 \\ 0 \\ 0 \end{bmatrix} \qquad \gamma_{WL} := \begin{bmatrix} 0 \\ 0 \\ 0.6 \\ 0 \end{bmatrix} \qquad \gamma_S := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1.0 \end{bmatrix}$$

$$M_{LC1_i} := \gamma_{DL_0} \cdot M_{DL_i} + \gamma_{Lr_0} \cdot M_{Lr_i} + \gamma_{WL_0} \cdot M_{WL_i} + \gamma_{S_0} \cdot M_{S_i} \qquad V_{LC1_i} := \gamma_{DL_0} \cdot V_{DL_i} + \gamma_{Lr_0} \cdot V_{Lr_i} + \gamma_{WL_0} \cdot V_{WL_i} + \gamma_{S_0} \cdot V_{S_i}$$

$$M_{LC2_i} := \gamma_{DL_1} \cdot M_{DL_i} + \gamma_{Lr_1} \cdot M_{Lr_i} + \gamma_{WL_1} \cdot M_{WL_i} + \gamma_{S_1} \cdot M_{S_i} \qquad V_{LC2_i} := \gamma_{DL_1} \cdot V_{DL_i} + \gamma_{Lr_1} \cdot V_{Lr_i} + \gamma_{WL_1} \cdot V_{WL_i} + \gamma_{S_1} \cdot V_{S_i}$$

$$M_{LC3_i} := \gamma_{DL_2} \cdot M_{DL_i} + \gamma_{Lr_2} \cdot M_{Lr_i} + \gamma_{WL_2} \cdot M_{WL_i} + \gamma_{S_2} \cdot M_{S_i} \qquad V_{LC3_i} := \gamma_{DL_2} \cdot V_{DL_i} + \gamma_{Lr_2} \cdot V_{Lr_i} + \gamma_{WL_2} \cdot V_{WL_i} + \gamma_{S_2} \cdot V_{S_i}$$

$$M_{LC4_i} := \gamma_{DL_3} \cdot M_{DL_i} + \gamma_{Lr_3} \cdot M_{Lr_i} + \gamma_{WL_3} \cdot M_{WL_i} + \gamma_{S_3} \cdot M_{S_i} \qquad V_{LC4_i} := \gamma_{DL_3} \cdot V_{DL_i} + \gamma_{Lr_3} \cdot V_{Lr_i} + \gamma_{WL_3} \cdot V_{WL_i} + \gamma_{S_3} \cdot V_{S_i}$$

SUMMARY OR RESULTS

	LC1	LC2	LC3	LC4
Maximum Moment	$\frac{\max\left(M_{LC1}\right)}{M_a} = 44\%$	$\frac{\max\left(M_{LC2}\right)}{M_a} = 68\%$	$\frac{\max\left(M_{LC3}\right)}{M_a} = 66\%$	$\frac{\max\left(M_{LC4}\right)}{M_a} = 70\%$
Minimum Moment	$\frac{min\left(M_{LC1}\right)}{M_a} = 0$	$\frac{min\left(M_{LC2}\right)}{M_a} = 0$	$\frac{min\left(M_{LC3}\right)}{M_a} = 0$	$\frac{min\left(M_{LC4}\right)}{M_a} = 0$
Maximum Shear	$\frac{\max\left(V_{LC1}\right)}{V_a} = 50\%$	$\frac{\max\left(V_{LC2}\right)}{V_a} = 78\%$	$\frac{\max\left(V_{LC3}\right)}{V_a} = 72\%$	$\frac{\max\left(V_{LC4}\right)}{V_a} = 81\%$
Minimum Shear	$\frac{min\left(V_{LC1}\right)}{V_a} = -48\%$	$\frac{min\left(V_{LC2}\right)}{V_a} = -77\%$	$\frac{min\left(V_{LC3}\right)}{V_a} = -68\%$	$\frac{min\left(V_{LC4}\right)}{V_a} = -79\%$

EXISTING ROOF JOIST IS ACCEPTABLE TO SUPPORT HVAC EQUIPMENT WITHOUT ADDITIONAL STRENGTHENING. MAXIMUM DCR = $\frac{\max\left(M_{LC4}\right)}{M_a} = 70\%$ **IS CONSERVATIVE DUE TO ASSUMPTION THAT LOAD IS DISTRIBUTED IN 2 JOISTS ONLY**

Check of critical roof joist on Building L

Figure 3. Critical roof joist on Building L

See Mathcad Calculation in following pages.

Calculation Description: Spreadsheet to calculate the load demand and compare with allowable loads of open web roof joists with the addition of the HVAC units . Joist Capacity is calculated per SJI Historical Load Tables

Limitations: HVAC unit is assumed to span perpendicular to roof joists. Wind load is applied to the long face of the equipment. ASD Load combinations using Dead, Live roof, snow, and horizontal wind loads are assumed.

Input and Notes:

1. Input values are highlighted in yellow
2. Reference documents like architectural roofing detail and SJI load table are included at the end of this spreasheet

---

Joist Properties

Joist selection

$\begin{bmatrix} w_{OWJ} \\ V_a \\ M_a \\ S_{jst} \end{bmatrix} :=$ Joist Name: 20H10

See building roof plan and SJI Historical Load Table

Jost spacing $S_{spcg} := 6\ ft$

See building roof plan

Joist weight $w_{OWJ} = 14.6\ plf$

Allowable shear $V_a = 7000\ lbf$

Allowable Moment $M_a = 789\ kip \cdot in$

Joist Span $S_{jst} = 32.25\ ft$

Load Demands

Roof dead load $\omega_{rf} := 28\ psf$

Distributed roof live load $\omega_{Lr} := 20\ psf$

Snow load $\omega_S := 22\ psf$

See snow load calculation spreadsheet (conservative)

Wind Load on roof (down) $\omega_{Wdn} := 16\ psf$

HVAC Properties

Weight includes HVAC unit, curb and steel members spanning between roof joists

Consider joist supports up to 2 HVAC units

$\begin{bmatrix} W_{HVAC.1} \\ H_{HVAC.1} \\ L_{HVAC.1} \\ B_{HVAC.1} \\ x_{1.HVAC.1} \\ x_{2.HVAC.1} \end{bmatrix} :=$ HVAC Unit: L1B

$\begin{bmatrix} W_{HVAC.2} \\ H_{HVAC.2} \\ L_{HVAC.2} \\ B_{HVAC.2} \\ x_{1.HVAC.2} \\ x_{2.HVAC.2} \end{bmatrix} :=$ HVAC Unit: None

Weight of HVAC Unit $W_{HVAC.1} = 1600\ lbf$ $W_{HVAC.2} = 0\ lbf$

HVAC unit dimensions

$H_{HVAC.1} = 51.0\ in$
$L_{HVAC.1} = 100.0\ in$
$B_{HVAC.1} = 63.0\ in$
$x_{1.HVAC.1} = 12.500\ ft$
$x_{2.HVAC.1} = 20.670\ ft$

$H_{HVAC.2} = 53.750\ in$
$L_{HVAC.2} = 74.000\ in$
$B_{HVAC.2} = 48.000\ in$
$x_{1.HVAC.2} = 12.000\ ft$
$x_{2.HVAC.2} = 15.000\ ft$

Curb height $H_{curb} := 24\ in$

Lateral wind pressure $p_{WL} := 54.8\ psf$ *Conservative*

Load Calculations: Equipment is assumed to span parallel to roof joists and wind load applied on long face of equipment

Distributed dead load from HVAC weight

$$w_{DL.1} := \frac{W_{HVAC.1}}{2 \cdot L_{HVAC.1}} \qquad w_{DL.1} = 96.0\ \frac{lbf}{ft}$$

$$w_{DL.2} := \frac{W_{HVAC.2}}{2 \cdot L_{HVAC.2}} \qquad w_{DL.2} = 0.0\ \frac{lbf}{ft}$$

Overturning moment due to wind load on equipment

$$M_{WL.HVAC.1} := p_{WL} \cdot L_{HVAC.1} \cdot \frac{\left(H_{HVAC.1} + H_{curb}\right)^2}{2} \qquad M_{WL.HVAC.1} = 8919\ lbf \cdot ft$$

$$M_{WL.HVAC.2} := \mathbf{if}\left(W_{HVAC.2} = 0\ ,0\ lbf \cdot ft\ , p_{WL} \cdot L_{HVAC.2} \cdot \frac{\left(H_{HVAC.2} + H_{curb}\right)^2}{2}\right) \qquad M_{WL.HVAC.2} = 0\ lbf \cdot ft$$

Distributed force couple on roof joist due to wind load on equipment

$$w_{WL.HVAC.1} := \frac{M_{WL.HVAC.1}}{S_{spcg} \cdot L_{HVAC.1}} \qquad w_{WL.HVAC.1} = 178\ \frac{lbf}{ft}$$

$$w_{WL.HVAC.2} := \mathbf{if}\left(W_{HVAC.2} = 0\ ,0\ \frac{lbf}{ft}\ , \frac{M_{WL.HVAC.2}}{S_{spcg} \cdot L_{HVAC.2}}\right) \qquad w_{WL.HVAC.2} = 0\ \frac{lbf}{ft}$$

Total distributed dead load on roof joist per linear foot $w_{DL} := w_{OWJ} + S_{spcg} \cdot \omega_{rf}$ $w_{DL} = 182.6\ plf$

Total distributed live roof load on roof joist (per linear foot) $w_{Lr} := \omega_{Lr} \cdot S_{spcg}$ $w_{Lr} = 120.0\ plf$

Total distributed snow load on roof joist (per linear foot) $w_S := \omega_S \cdot S_{spcg}$ $w_S = 132.0\ plf$

Total distributed wind load downward on roof joist (per linear foot) $w_{Wdn} := \omega_{Wdn} \cdot S_{spcg}$ $w_{Wdn} = 96.000\ plf$

Moment and shear demands from distributed loads

$$M_{dist}(x, w) := \frac{w}{2} \cdot x \cdot (S_{jst} - x)$$

$$V_{dist}(x, w) := w \cdot \left(\frac{S_{jst}}{2} - x\right)$$

Base reaction force due to distributed load on partial length of joist

$$R_1(w, x_1, x_2) := w \cdot \frac{(x_2 - x_1)}{S_{jst}} \cdot \left(S_{jst} - \frac{(x_1 + x_2)}{2}\right)$$

Roof joist base Reaction due to point loads

$$R_2(w, x_1, x_2) := w \cdot (x_2 - x_1) \cdot \frac{(x_1 + x_2)}{2 \cdot S_{jst}}$$

Moment due to distributed load on partial length of joist

$$M_{dist.ptl}(x, w, x_1, x_2) := \begin{cases} \text{if } x \geq 0 \text{ in} \wedge x \leq x_1 \\ \quad R_1(w, x_1, x_2) \cdot x \\ \text{else if } x \leq x_2 \\ \quad R_1(w, x_1, x_2) \cdot x - w \cdot \dfrac{(x - x_1)^2}{2} \\ \text{else if } x \leq S_{jst} \\ \quad R_2(w, x_1, x_2) \cdot (S_{jst} - x) \end{cases}$$

$$V_{dist.ptl}(x, w, x_1, x_2) := \begin{cases} \text{if } x \geq 0 \text{ in} \wedge x \leq x_1 \\ \quad R_1(w, x_1, x_2) \\ \text{else if } x \leq x_2 \\ \quad R_1(w, x_1, x_2) - w \cdot (x - x_1) \\ \text{else if } x \leq S_{jst} \\ \quad -R_2(w, x_1, x_2) \end{cases}$$

Defining 100 discrete points along roof joist

$$i := 0 .. 100 \qquad x_{0_i} := \frac{i}{100} \cdot S_{jst}$$

Moment due to DL

$$M_{DL_i} := M_{dist}(x_{0_i}, w_{DL}) + M_{dist.ptl}(x_{0_i}, w_{DL.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + M_{dist.ptl}(x_{0_i}, w_{DL.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Shear due to DL

$$V_{DL_i} := V_{dist}(x_{0_i}, w_{DL}) + V_{dist.ptl}(x_{0_i}, w_{DL.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + V_{dist.ptl}(x_{0_i}, w_{DL.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Moment due to live load

$$M_{Lr_i} := M_{dist}(x_{0_i}, w_{Lr})$$

Shear due to live load

$$V_{Lr_i} := V_{dist}(x_{0_i}, w_{Lr})$$

Moment due to snow load

$$M_{S_i} := M_{dist}(x_{0_i}, w_S)$$

Shear due to snow load

$$V_{S_i} := V_{dist}(x_{0_i}, w_S)$$

Moment due to Wind

$$M_{WL_i} := M_{dist}(x_{0_i}, w_{Wdn}) + M_{dist.ptl}(x_{0_i}, w_{WL.HVAC.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + M_{dist.ptl}(x_{0_i}, w_{WL.HVAC.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Horizontal wind load on equipment

Shear due to Wind

$$V_{WL_i} := V_{dist}(x_{0_i}, w_{Wdn}) + V_{dist.ptl}(x_{0_i}, w_{WL.HVAC.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + V_{dist.ptl}(x_{0_i}, w_{WL.HVAC.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Load combination factors

$$\gamma_{DL} := \begin{bmatrix} 1.0 \\ 1.0 \\ 1.0 \\ 1.0 \end{bmatrix} \qquad \gamma_{Lr} := \begin{bmatrix} 0 \\ 1.0 \\ 0 \\ 0 \end{bmatrix} \qquad \gamma_{WL} := \begin{bmatrix} 0 \\ 0 \\ 0.6 \\ 0 \end{bmatrix} \qquad \gamma_S := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1.0 \end{bmatrix}$$

$$M_{LC1_i} := \gamma_{DL_0} \cdot M_{DL_i} + \gamma_{Lr_0} \cdot M_{Lr_i} + \gamma_{WL_0} \cdot M_{WL_i} + \gamma_{S_0} \cdot M_{S_i} \qquad V_{LC1_i} := \gamma_{DL_0} \cdot V_{DL_i} + \gamma_{Lr_0} \cdot V_{Lr_i} + \gamma_{WL_0} \cdot V_{WL_i} + \gamma_{S_0} \cdot V_{S_i}$$

$$M_{LC2_i} := \gamma_{DL_1} \cdot M_{DL_i} + \gamma_{Lr_1} \cdot M_{Lr_i} + \gamma_{WL_1} \cdot M_{WL_i} + \gamma_{S_1} \cdot M_{S_i} \qquad V_{LC2_i} := \gamma_{DL_1} \cdot V_{DL_i} + \gamma_{Lr_1} \cdot V_{Lr_i} + \gamma_{WL_1} \cdot V_{WL_i} + \gamma_{S_1} \cdot V_{S_i}$$

$$M_{LC3_i} := \gamma_{DL_2} \cdot M_{DL_i} + \gamma_{Lr_2} \cdot M_{Lr_i} + \gamma_{WL_2} \cdot M_{WL_i} + \gamma_{S_2} \cdot M_{S_i} \qquad V_{LC3_i} := \gamma_{DL_2} \cdot V_{DL_i} + \gamma_{Lr_2} \cdot V_{Lr_i} + \gamma_{WL_2} \cdot V_{WL_i} + \gamma_{S_2} \cdot V_{S_i}$$

$$M_{LC4_i} := \gamma_{DL_3} \cdot M_{DL_i} + \gamma_{Lr_3} \cdot M_{Lr_i} + \gamma_{WL_3} \cdot M_{WL_i} + \gamma_{S_3} \cdot M_{S_i} \qquad V_{LC4_i} := \gamma_{DL_3} \cdot V_{DL_i} + \gamma_{Lr_3} \cdot V_{Lr_i} + \gamma_{WL_3} \cdot V_{WL_i} + \gamma_{S_3} \cdot V_{S_i}$$

SUMMARY OR RESULTS

	LC1	LC2	LC3	LC4
Maximum Moment	$\frac{\max\left(M_{LC1}\right)}{M_a} = 44\%$	$\frac{\max\left(M_{LC2}\right)}{M_a} = 68\%$	$\frac{\max\left(M_{LC3}\right)}{M_a} = 65\%$	$\frac{\max\left(M_{LC4}\right)}{M_a} = 71\%$
Minimum Moment	$\frac{min\left(M_{LC1}\right)}{M_a} = 0$	$\frac{min\left(M_{LC2}\right)}{M_a} = 0$	$\frac{min\left(M_{LC3}\right)}{M_a} = 0$	$\frac{min\left(M_{LC4}\right)}{M_a} = 0$
Maximum Shear	$\frac{\max\left(V_{LC1}\right)}{V_a} = 48\%$	$\frac{\max\left(V_{LC2}\right)}{V_a} = 75\%$	$\frac{\max\left(V_{LC3}\right)}{V_a} = 67\%$	$\frac{\max\left(V_{LC4}\right)}{V_a} = 78\%$
Minimum Shear	$\frac{min\left(V_{LC1}\right)}{V_a} = -48\%$	$\frac{min\left(V_{LC2}\right)}{V_a} = -75\%$	$\frac{min\left(V_{LC3}\right)}{V_a} = -68\%$	$\frac{min\left(V_{LC4}\right)}{V_a} = -78\%$

EXISTING ROOF JOIST IS ACCEPTABLE TO SUPPORT HVAC EQUIPMENT WITHOUT ADDITIONAL STRENGTHENING. MAXIMUM DCR = $\frac{\max\left(M_{LC4}\right)}{M_a} = 71\%$ **IS CONSERVATIVE DUE TO ASSUMPTION THAT LOAD IS DISTRIBUTED IN 2 JOISTS ONLY**

Check of critical roof joist on Building B

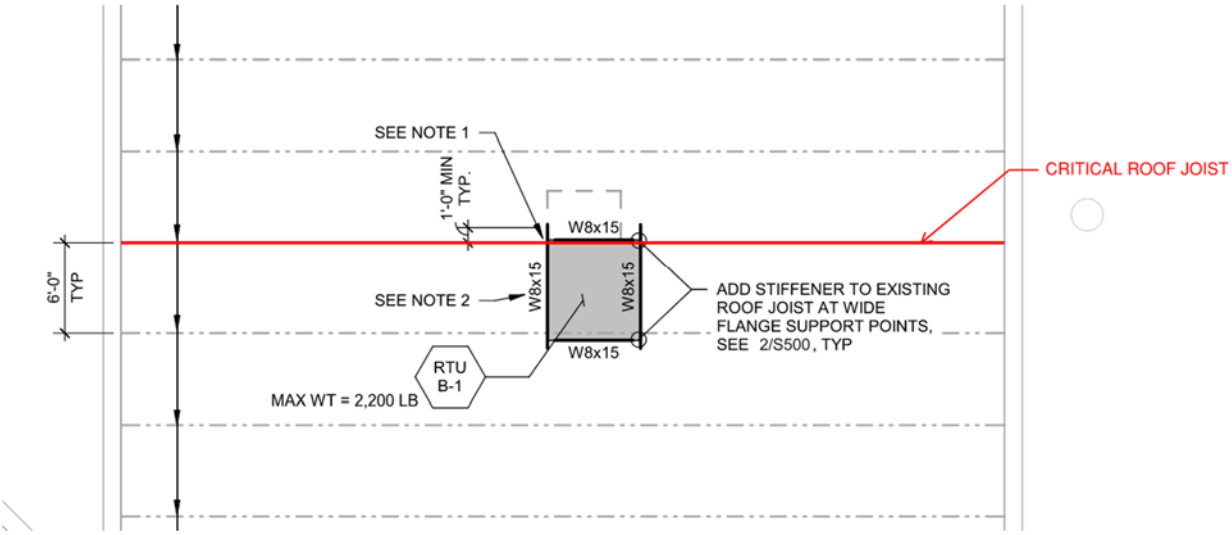


Figure 4. Critical roof joist on Building B

See MathCad calculation in following pages

Calculation Description: Spreadsheet to calculate the load demand and compare with allowable loads of open web roof joists with the addition of the HVAC units . Joist Capacity is calculated per SJI Historical Load Tables

Limitations: HVAC unit is assumed to span perpendicular to roof joists. Wind load is applied to the long face of the equipment. ASD Load combinations using Dead, Live roof, snow, and horizontal wind loads are assumed.

Input and Notes:

1. Input values are highlighted in yellow
2. Reference documents like architectural roofing detail and SJI load table are included at the end of this spreasheet

---

Joist Properties

Joist selection

$\begin{bmatrix} w_{OWJ} \\ V_a \\ M_a \\ S_{jst} \end{bmatrix} :=$ Joist Name: 36LH10

See building roof plan and SJI Historical Load Table

Jost spacing $S_{spcg} := 6\ ft$

See building roof plan

Joist weight $w_{OWJ} = 21.0\ plf$

Allowable shear $V_a = 26100\ lbf$

Allowable Moment $M_a = 2265\ kip \cdot in$

Joist Span $S_{jst} = 59.00\ ft$

Load Demands

Roof dead load $\omega_{rf} := 28\ psf$

Distributed roof live load $\omega_{Lr} := 20\ psf$

Snow load $\omega_S := 22\ psf$

See snow load calculation spreadsheet (conservative)

Wind Load on roof (down) $\omega_{Wdn} := 16\ psf$

HVAC Properties

Weight includes HVAC unit, curb and steel members spanning between roof joists

Consider joist supports up to 2 HVAC units

$\begin{bmatrix} W_{HVAC.1} \\ H_{HVAC.1} \\ L_{HVAC.1} \\ B_{HVAC.1} \\ x_{1.HVAC.1} \\ x_{2.HVAC.1} \end{bmatrix} :=$ HVAC Unit: Gym

$\begin{bmatrix} W_{HVAC.2} \\ H_{HVAC.2} \\ L_{HVAC.2} \\ B_{HVAC.2} \\ x_{1.HVAC.2} \\ x_{2.HVAC.2} \end{bmatrix} :=$ HVAC Unit: None

Weight of HVAC Unit $W_{HVAC.1} = 2200\ lbf$ $W_{HVAC.2} = 0\ lbf$

HVAC unit dimensions

$H_{HVAC.1} = 72.1\ in$ $H_{HVAC.2} = 53.750\ in$

$L_{HVAC.1} = 78.0\ in$ $L_{HVAC.2} = 74.000\ in$

$B_{HVAC.1} = 78.0\ in$ $B_{HVAC.2} = 48.000\ in$

$x_{1.HVAC.1} = 28.500\ ft$ $x_{1.HVAC.2} = 12.000\ ft$

$x_{2.HVAC.1} = 34.670\ ft$ $x_{2.HVAC.2} = 15.000\ ft$

Curb height $H_{curb} := 24\ in$

Lateral wind pressure $p_{WL} := 54.8\ psf$ *Conservative*

Load Calculations: Equipment is assumed to span parallel to roof joists and wind load applied on long face of equipment

Distributed dead load from HVAC weight

$$w_{DL.1} := \frac{W_{HVAC.1}}{2 \cdot L_{HVAC.1}} \qquad w_{DL.1} = 169.2\ \frac{lbf}{ft}$$

$$w_{DL.2} := \frac{W_{HVAC.2}}{2 \cdot L_{HVAC.2}} \qquad w_{DL.2} = 0.0\ \frac{lbf}{ft}$$

Overturning moment due to wind load on equipment

$$M_{WL.HVAC.1} := p_{WL} \cdot L_{HVAC.1} \cdot \frac{\left(H_{HVAC.1} + H_{curb}\right)^2}{2} \qquad M_{WL.HVAC.1} = 11422\ lbf \cdot ft$$

$$M_{WL.HVAC.2} := \text{if}\left(W_{HVAC.2} = 0\ ,\ 0\ lbf \cdot ft\ ,\ p_{WL} \cdot L_{HVAC.2} \cdot \frac{\left(H_{HVAC.2} + H_{curb}\right)^2}{2}\right) \qquad M_{WL.HVAC.2} = 0\ lbf \cdot ft$$

Distributed force couple on roof joist due to wind load on equipment

$$w_{WL.HVAC.1} := \frac{M_{WL.HVAC.1}}{S_{spcg} \cdot L_{HVAC.1}} \qquad w_{WL.HVAC.1} = 293\ \frac{lbf}{ft}$$

$$w_{WL.HVAC.2} := \text{if}\left(W_{HVAC.2} = 0\ ,\ 0\ \frac{lbf}{ft}\ ,\ \frac{M_{WL.HVAC.2}}{S_{spcg} \cdot L_{HVAC.2}}\right) \qquad w_{WL.HVAC.2} = 0\ \frac{lbf}{ft}$$

Total distributed dead load on roof joist per linear foot $w_{DL} := w_{OWJ} + S_{spcg} \cdot \omega_{rf}$ $w_{DL} = 189.0\ plf$

Total distributed live roof load on roof joist (per linear foot) $w_{Lr} := \omega_{Lr} \cdot S_{spcg}$ $w_{Lr} = 120.0\ plf$

Total distributed snow load on roof joist (per linear foot) $w_S := \omega_S \cdot S_{spcg}$ $w_S = 132.0\ plf$

Total distributed wind load downward on roof joist (per linear foot) $w_{Wdn} := \omega_{Wdn} \cdot S_{spcg}$ $w_{Wdn} = 96.000\ plf$

Moment and shear demands from distributed loads

$$M_{dist}\left(x\ ,w\right) := \frac{w}{2} \cdot x \cdot \left(S_{jst} - x\right)$$

$$V_{dist}\left(x\ ,w\right) := w \cdot \left(\frac{S_{jst}}{2} - x\right)$$

Base reaction force due to distributed load on partial length of joist

$$R_1\left(w\ ,x_1\ ,x_2\right) := w \cdot \frac{\left(x_2 - x_1\right)}{S_{jst}} \cdot \left(S_{jst} - \frac{\left(x_1 + x_2\right)}{2}\right)$$

Roof joist base Reaction due to point loads

$$R_2\left(w\ ,x_1\ ,x_2\right) := w \cdot \left(x_2 - x_1\right) \cdot \frac{\left(x_1 + x_2\right)}{2 \cdot S_{jst}}$$

Moment due to distributed load on partial length of joist

$$M_{dist.ptl}(x, w, x_1, x_2) := \begin{cases} \text{if } x \geq 0 \text{ in} \wedge x \leq x_1 \\ \quad R_1(w, x_1, x_2) \cdot x \\ \text{else if } x \leq x_2 \\ \quad R_1(w, x_1, x_2) \cdot x - w \cdot \dfrac{(x - x_1)^2}{2} \\ \text{else if } x \leq S_{jst} \\ \quad R_2(w, x_1, x_2) \cdot (S_{jst} - x) \end{cases}$$

$$V_{dist.ptl}(x, w, x_1, x_2) := \begin{cases} \text{if } x \geq 0 \text{ in} \wedge x \leq x_1 \\ \quad R_1(w, x_1, x_2) \\ \text{else if } x \leq x_2 \\ \quad R_1(w, x_1, x_2) - w \cdot (x - x_1) \\ \text{else if } x \leq S_{jst} \\ \quad -R_2(w, x_1, x_2) \end{cases}$$

Defining 100 discrete points along roof joist

$$i := 0 .. 100 \qquad x_{0_i} := \frac{i}{100} \cdot S_{jst}$$

Moment due to DL

$$M_{DL_i} := M_{dist}(x_{0_i}, w_{DL}) + M_{dist.ptl}(x_{0_i}, w_{DL.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + M_{dist.ptl}(x_{0_i}, w_{DL.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Shear due to DL

$$V_{DL_i} := V_{dist}(x_{0_i}, w_{DL}) + V_{dist.ptl}(x_{0_i}, w_{DL.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + V_{dist.ptl}(x_{0_i}, w_{DL.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Moment due to live load

$$M_{Lr_i} := M_{dist}(x_{0_i}, w_{Lr})$$

Shear due to live load

$$V_{Lr_i} := V_{dist}(x_{0_i}, w_{Lr})$$

Moment due to snow load

$$M_{S_i} := M_{dist}(x_{0_i}, w_S)$$

Shear due to snow load

$$V_{S_i} := V_{dist}(x_{0_i}, w_S)$$

Moment due to Wind

$$M_{WL_i} := M_{dist}(x_{0_i}, w_{Wdn}) + M_{dist.ptl}(x_{0_i}, w_{WL.HVAC.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + M_{dist.ptl}(x_{0_i}, w_{WL.HVAC.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Horizontal wind load on equipment

Shear due to Wind

$$V_{WL_i} := V_{dist}(x_{0_i}, w_{Wdn}) + V_{dist.ptl}(x_{0_i}, w_{WL.HVAC.1}, x_{1.HVAC.1}, x_{2.HVAC.1}) + V_{dist.ptl}(x_{0_i}, w_{WL.HVAC.2}, x_{1.HVAC.2}, x_{2.HVAC.2})$$

Load combination factors

$$\gamma_{DL} := \begin{bmatrix} 1.0 \\ 1.0 \\ 1.0 \\ 1.0 \end{bmatrix} \qquad \gamma_{Lr} := \begin{bmatrix} 0 \\ 1.0 \\ 0 \\ 0 \end{bmatrix} \qquad \gamma_{WL} := \begin{bmatrix} 0 \\ 0 \\ 0.6 \\ 0 \end{bmatrix} \qquad \gamma_S := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1.0 \end{bmatrix}$$

$$M_{LC1_i} := \gamma_{DL_0} \cdot M_{DL_i} + \gamma_{Lr_0} \cdot M_{Lr_i} + \gamma_{WL_0} \cdot M_{WL_i} + \gamma_{S_0} \cdot M_{S_i} \qquad V_{LC1_i} := \gamma_{DL_0} \cdot V_{DL_i} + \gamma_{Lr_0} \cdot V_{Lr_i} + \gamma_{WL_0} \cdot V_{WL_i} + \gamma_{S_0} \cdot V_{S_i}$$

$$M_{LC2_i} := \gamma_{DL_1} \cdot M_{DL_i} + \gamma_{Lr_1} \cdot M_{Lr_i} + \gamma_{WL_1} \cdot M_{WL_i} + \gamma_{S_1} \cdot M_{S_i} \qquad V_{LC2_i} := \gamma_{DL_1} \cdot V_{DL_i} + \gamma_{Lr_1} \cdot V_{Lr_i} + \gamma_{WL_1} \cdot V_{WL_i} + \gamma_{S_1} \cdot V_{S_i}$$

$$M_{LC3_i} := \gamma_{DL_2} \cdot M_{DL_i} + \gamma_{Lr_2} \cdot M_{Lr_i} + \gamma_{WL_2} \cdot M_{WL_i} + \gamma_{S_2} \cdot M_{S_i} \qquad V_{LC3_i} := \gamma_{DL_2} \cdot V_{DL_i} + \gamma_{Lr_2} \cdot V_{Lr_i} + \gamma_{WL_2} \cdot V_{WL_i} + \gamma_{S_2} \cdot V_{S_i}$$

$$M_{LC4_i} := \gamma_{DL_3} \cdot M_{DL_i} + \gamma_{Lr_3} \cdot M_{Lr_i} + \gamma_{WL_3} \cdot M_{WL_i} + \gamma_{S_3} \cdot M_{S_i} \qquad V_{LC4_i} := \gamma_{DL_3} \cdot V_{DL_i} + \gamma_{Lr_3} \cdot V_{Lr_i} + \gamma_{WL_3} \cdot V_{WL_i} + \gamma_{S_3} \cdot V_{S_i}$$

SUMMARY OR RESULTS

	LC1	LC2	LC3	LC4
Maximum Moment	$\frac{\max\left(M_{LC1}\right)}{M_a} = 51\%$	$\frac{\max\left(M_{LC2}\right)}{M_a} = 79\%$	$\frac{\max\left(M_{LC3}\right)}{M_a} = 72\%$	$\frac{\max\left(M_{LC4}\right)}{M_a} = 82\%$
Minimum Moment	$\frac{min\left(M_{LC1}\right)}{M_a} = 0$	$\frac{min\left(M_{LC2}\right)}{M_a} = 0$	$\frac{min\left(M_{LC3}\right)}{M_a} = 0$	$\frac{min\left(M_{LC4}\right)}{M_a} = 0$
Maximum Shear	$\frac{\max\left(V_{LC1}\right)}{V_a} = 23\%$	$\frac{\max\left(V_{LC2}\right)}{V_a} = 37\%$	$\frac{\max\left(V_{LC3}\right)}{V_a} = 32\%$	$\frac{\max\left(V_{LC4}\right)}{V_a} = 38\%$
Minimum Shear	$\frac{min\left(V_{LC1}\right)}{V_a} = -24\%$	$\frac{min\left(V_{LC2}\right)}{V_a} = -37\%$	$\frac{min\left(V_{LC3}\right)}{V_a} = -32\%$	$\frac{min\left(V_{LC4}\right)}{V_a} = -38\%$

EXISTING ROOF JOIST IS ACCEPTABLE TO SUPPORT HVAC EQUIPMENT WITHOUT ADDITIONAL STRENGTHENING. MAXIMUM DCR = $\frac{\max\left(M_{LC4}\right)}{M_a} = 82\%$ **IS CONSERVATIVE DUE TO ASSUMPTION THAT LOAD IS DISTRIBUTED IN 2 JOISTS ONLY**

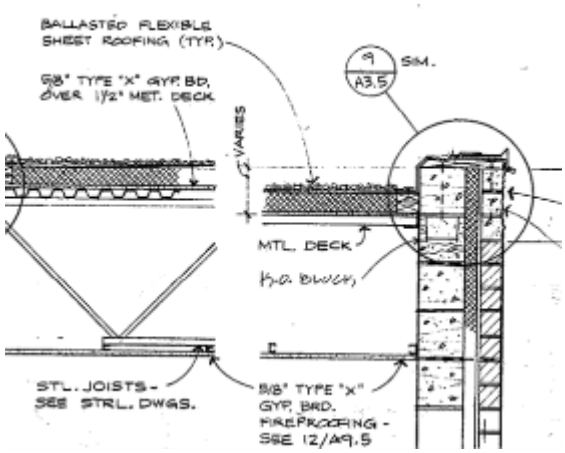


Figure 1: Roofing diagram

LOADS ABOVE THE COLORED LINES ARE GOVERNED BY SHEAR.

Joist Designation	8H3	10H3	10H4	12H3	12H4	12H5	12H6	14H3	14H4	14H5	14H6	14H7	16H4	16H5	16H6	16H7	16H8
Nominal *Depth (in.)	8	10	10	12	12	12	12	14	14	14	14	14	16	16	16	16	16
Resist. Moment (in.-lbs.)	91,000	116,000	148,000	140,000	180,000	222,000	260,000	165,000	212,000	259,000	307,000	369,000	221,000	289,000	344,000	413,000	478,000
Max. End React. (lbs.)	2400	2500	2800	2800	3200	3600	3900	3200	3500	3800	4200	4600	3800	4300	4600	4900	5200
†Approx. Wt. (lbs./ft.)	5.0	5.0	6.1	5.2	6.2	7.1	8.2	5.5	6.5	7.4	8.6	10.0	6.5	7.8	8.6	10.3	11.4
Span in Feet																	
8	600																
9	533																
10	480 460	500	560														
11	436 345	455	509														
12	400 266	417	467	467	533	600	650										
13	359 209	385 317	431 417	431	492	554	600										
14	310 167	357 270	400 334	400 393	457	514	557	457	500	543	600	657					
15	270 138	333 219	373 271	373 320	427 418	480	520	427	467	507	560	613					
16	237 112	302 181	350 223	350 264	400 345	450 404	488 480	400 366	438	475	525	575	475	538	575	613	650
17		268 151	329 186	323 220	376 287	424 337	459 400	376 305	412 398	447	494	541	447	506	541	576	612
18		239 127	305 157	288 185	356 242	400 284	433 337	340 257	389 336	422 393	467	511	422 413	478	511	544	578
19		214 108	273 133	259 157	332 206	379 241	411 286	305 218	368 285	400 334	442 399	484 470	400 351	453 432	484	516	547
20		193 92	247 114	233 135	300 177	360 207	390 246	275 187	350 245	380 287	420 342	460 403	368 331	430 370	460 437	490	520
21				212 117	272 152	336 179	371 212	249 162	320 212	362 248	400 295	438 348	334 260	410 320	438 377	467 454	495
22				193 101	248 133	306 155	355 185	227 141	292 184	345 215	382 257	418 302	304 226	391 278	418 328	445 395	473 454
23				176 89	227 116	280 136	328 162	208 123	267 151	326 189	365 225	410 265	279 198	364 243	400 287	426 346	452 398
24				162 78	208 102	257 120	301 142	191 108	245 142	300 166	350 198	383 233	256 174	334 214	383 253	408 304	433 353
25								176 96	226 125	276 147	327 175	368 206	236 154	308 190	367 224	392 269	416 310
26								163 85	209 111	255 131	303 156	354 183	218 137	285 169	339 199	377 239	400 275
27								151 76	194 99	237 117	281 139	337 164	202 122	264 151	315 177	363 214	385 246
28								140 68	180 89	220 104	261 125	314 147	188 110	246 135	293 159	353 192	371 220
29													175 99	229 121	273 143	327 172	359 198
30													164 89	214 110	255 129	306 156	347 179
31													153 81	200 99	239 117	287 141	332 162
32													144 74	188 90	224 107	269 128	311 148

See page LT-48 for notes

For Joist Depths 18" to 22" inclusive

Joist Designation	18H5	18H6	18H7	18H8	18H9	18H10	18H11	20H5	20H6	20H7	20H8	20H9	20H10	20H11	22H6	22H7	22H8	22H9	22H10	22H11
Nominal *Depth (in.)	18	18	18	18	18	18	18	20	20	20	20	20	20	20	22	22	22	22	22	22
Resist. Moment (in.-lbs.)	325,000	383,000	466,000	540,000	627,000	705,000	814,000	365,000	406,000	499,000	602,000	701,000	789,000	912,000	422,000	526,000	653,000	776,000	873,000	1,009,000
Max. End React. (lbs.)	4500	4800	5200	5400	5900	6600	7600	4800	5100	5400	5600	6400	7000	7900	5400	5600	5800	6700	7200	8100
†Approx. Wt. (lbs./ft.)	8.0	9.2	10.4	11.6	12.6	14.0	15.8	8.4	9.6	10.7	12.2	13.2	14.6	16.4	9.7	10.7	12.0	13.8	15.2	16.9
Span in Feet 18	500	533	578	600																
19	474	505	547	568	621															
20	450	480	520	540	590			480	510	540	560	640								
21	429 409	457	495	514	562	629		457	486	514	533	610								
22	409 356	436 420	473	491	536	600		436	464	491	509	582	636		491	509	527	609		
23	391 312	417 368	452 441	470	513	574		417 380	443 434	470	487	557	609		470	487	504	583	626	
24	375 274	400 324	433 388	450 444	492 484	550 546	633 619	400 335	425 382	450	467	533	583		450 446	467	483	558	600	
25	347 243	384 286	416 343	432 393	472 428	528 483	608 548	384 296	408 338	432 411	448	512	560	632	432 395	448	464	536	576	648
26	321 216	369 255	400 305	415 349	454 380	508 429	585 487	360 263	392 300	415 365	431	492 476	538	608	415 351	431 426	446	515	554	623
27	297 193	350 227	385 272	400 312	437 340	489 383	563 435	334 235	371 268	400 326	415 392	474 425	519 480	585 545	386 313	415 380	430	496	533	600
28	276 173	326 204	371 244	386 280	421 305	471 344	543 390	310 211	345 240	386 292	400 352	457 381	500 431	564 488	359 281	400 341	414	479 468	514	579
29	258 155	304 184	359 220	372 252	407 274	455 309	524 351	289 190	322 216	372 263	386 317	441 343	483 388	545 440	335 253	386 307	400 379	462 421	497 473	559 539
30	241 140	284 166	345 199	360 227	393 248	440 280	507 317	270 171	301 195	360 238	373 286	427 310	467 350	527 397	313 228	373 277	387 343	447 381	480 428	540 487
31	225 127	266 150	323 180	348 206	381 224	426 253	490 287	253 155	282 177	346 215	361 259	413 281	452 317	510 360	293 207	361 251	374 311	432 345	465 387	523 441
32	212 116	249 137	303 164	338 187	369 204	413 230	475 261	238 141	264 161	325 196	350 236	400 255	438 288	494 327	275 188	342 228	363 282	419 314	450 352	506 401
33	199 106	234 125	285 149	327 171	358 186	400 210	461 238	223 129	249 147	305 178	339 215	388 233	424 263	479 298	258 172	322 208	352 257	406 286	436 321	491 366
34	187 96	221 114	269 136	311 156	347 170	388 192	447 218	210 118	234 134	288 163	329 196	378 213	412 240	465 273	243 157	303 190	341 235	394 261	424 294	476 335
35	177 88	208 104	254 125	294 143	337 156	377 176	434 200	199 108	221 123	272 150	320 180	366 195	400 220	451 250	230 144	286 175	331 216	383 240	411 269	463 307
36	167 81	197 96	240 115	278 132	323 143	363 162	419 183	188 99	209 113	257 137	310 166	356 179	389 203	439 230	217 132	271 160	322 198	372 220	400 247	450 282
37								178 91	198 104	243 127	293 152	341 165	378 187	427 212	206 122	256 148	314 183	362 203	389 228	438 260
38								169 84	187 96	230 117	278 141	324 153	364 172	416 195	195 112	243 136	301 169	353 187	379 210	426 240
39								160 78	178 89	219 108	264 130	307 141	346 159	400 181	185 104	231 126	286 156	340 173	369 195	415 222
40								152 72	169 82	208 100	251 121	292 131	329 148	380 168	176 96	219 117	272 145	323 161	360 180	405 205
41															167 89	209 109	259 134	308 149	346 167	395 191
42															159 83	199 101	247 125	293 139	330 156	381 177
43															152 78	190 94	235 116	280 129	315 145	364 165
44															145 72	181 88	225 109	267 121	301 136	347 154

			42–56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
36LH**07**	16	36	16800	292 177	283 168	274 160	266 153	258 146	251 140	244 134	237 128	230 122	224 117	218 112	212 107	207 103	201 99	196 95	191 91
36LH**08**	18	36	18500	321 194	311 185	302 176	293 168	284 160	276 153	268 146	260 140	253 134	246 128	239 123	233 118	227 113	221 109	215 104	209 100
36LH**09**	21	36	23700	411 247	398 235	386 224	374 214	363 204	352 195	342 186	333 179	323 171	314 163	306 157	297 150	289 144	282 138	275 133	267 127
36LH**10**	21	36	26100	454 273	440 260	426 248	413 236	401 225	389 215	378 206	367 197	357 188	347 180	338 173	328 165	320 159	311 152	303 146	295 140
36LH**11**	23	36	28500	495 297	480 283	465 269	451 257	438 246	425 234	412 224	401 214	389 205	378 196	368 188	358 180	348 173	339 166	330 159	322 153
36LH**12**	25	36	34100	593 354	575 338	557 322	540 307	523 292	508 279	493 267	478 255	464 243	450 232	437 222	424 213	412 204	400 195	389 187	378 179
36LH**13**	30	36	40100	697 415	675 395	654 376	634 359	615 342	596 327	579 312	562 298	546 285	531 273	516 262	502 251	488 240	475 231	463 222	451 213
36LH**14**	36	36	44200	768 456	755 434	729 412	706 392	683 373	661 356	641 339	621 323	602 309	584 295	567 283	551 270	535 259	520 247	505 237	492 228
36LH**15**	36	36	46600	809 480	795 464	781 448	769 434	744 413	721 394	698 375	677 358	656 342	637 327	618 312	600 299	583 286	567 274	551 263	536 252

See page LT-57 for notes

CHECK OF HVAC SUPPORT RAILS

Calculation Description: Spreadsheet to calculate the load demands on rails support HVAC units and its connection to the roof joist

Limitations: HVAC unit is assumed to span perpendicular to roof joists. Wind load is applied to the long face of the equipment. ASD Load combinations using Dead, Live roof, snow, and horizontal wind loads are assumed.

Input and Notes:

1. Input values are highlighted in yellow
2. Reference documents like architectural roofing detail and SJI load table are included at the end of this spreasheet

HVAC Properties

Weight includes HVAC unit, curb and steel members spanning between roof joists

Consider joist supports up to 2 HVAC units

$\begin{bmatrix} W_{HVAC} \\ H_{HVAC} \\ L_{HVAC} \\ B_{HVAC} \end{bmatrix} :=$ HVAC Unit: D3A

Weight of HVAC Unit $W_{HVAC} = 2900\ lbf$

HVAC unit dimensions $H_{HVAC} = 85.9\ in$

$L_{HVAC} = 118.6\ in$

$B_{HVAC} = 73.4\ in$

Curb height $H_{curb} := 24\ in$

Lateral wind pressure $p_{WL} := 54.8\ psf$

Conservative

Load Calculations: Equipment is assumed to span perpendicular to roof joists and wind load applied on long face of equipment

Length of HVAC 1 tributary to single roof joist $L_{HVAC.T} := 6\ ft$

Distributed dead load on support rail $w_{DL} := \frac{W_{HVAC}}{2 \cdot L_{HVAC}}$ $w_{DL} = 146.712\ plf$

Reaction at base of support rail $R_{DL} := w_{DL} \cdot L_{HVAC.T}$ $R_{DL} = 880.3\ lbf$

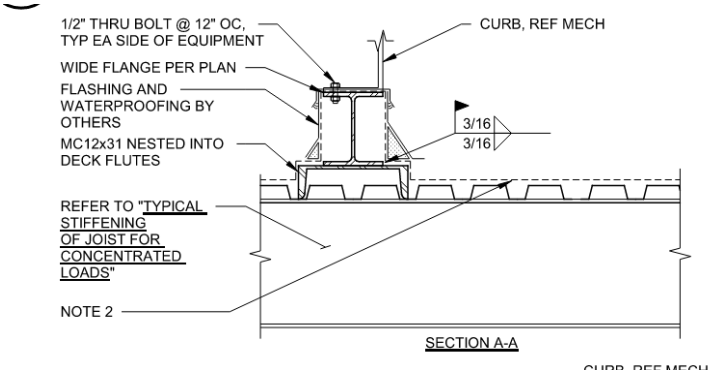
Total Overturning moment due to wind load on equipment $M_{WL.HVAC} := p_{WL} \cdot L_{HVAC} \cdot \frac{(H_{HVAC} + H_{curb})^2}{2}$ $M_{WL.HVAC} = 22714\ lbf \cdot ft$

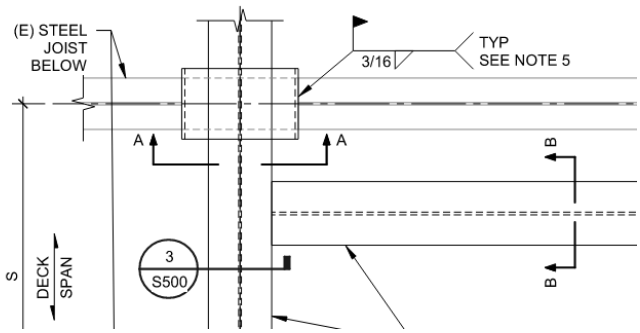
Distributed vertical load on support rail due to wind on equipment $w_{WL} := \frac{M_{WL.HVAC}}{B_{HVAC} \cdot L_{HVAC}}$ $w_{WL} = 375.724\ plf$

Reaction at base of support rail $R_{WL} := w_{WL} \cdot L_{HVAC.T}$ $R_{WL} = 2254.3\ lbf$

See Tekla Tedds check of a W8x15 RTU rail in the following pages

Check of connection between rail and roof joist





Vertical load at top of rail

$R_{DL} = 880.270$ *lbf*

$R_{WL} = 2254.342$ *lbf*

Shear load at top of rail

$V_{DL} := 0$ *lbf*

$V_{WL} := p_{WL} \cdot \frac{(H_{HVAC} + H_{curb}) \cdot L_{HVAC.T}}{2}$

$V_{WL} = 1505.630$ *lbf*

Lever arm of shear load on top of rail

$d_{top} := 12$ *in*

Conseratively assumed as the width of the channel flange plus the height of the rail

Lever arm of weld pair

$d_{weld} := 4$ *in*

Conservatively assumed as the width of the rail flange

Design load for connection

$R_u := \frac{0.9\ R_{DL} - 1.0 \cdot R_{WL}}{2} - V_{WL} \cdot \frac{d_{top}}{d_{weld}}$

$R_u = -5247.940$ *lbf*

$V_u := V_{WL}$

Total load on weld

$F_{u.weld} := \sqrt{R_u^{\ 2} + V_u^{\ 2}}$

$F_{u.weld} = 5459.651$ *lbf*

Weld throat (in 1/16th of an inch)

$D_{weld} := 3$

Weld length

$l_{weld} := 1.5$ *in*

Assuming we only have 1 1/2 inch width of the roof joist surface to weld

Weld capacity

$\phi R_{n.weld} := 1.392 \cdot D_{weld} \cdot l_{weld} \cdot \frac{kip}{in}$

$\phi R_{n.weld} = 6.264$ *kip*

Demand capacity ratio

$DCR_{weld} := \frac{F_{u.weld}}{\phi R_{n.weld}}$

$DCR_{weld} = 87\%$

A 3/16" x 1 1/2" weld between the rail and the channel below and also between the MC channel and the roof joist below is sufficient to resist the shear + uplift loads with $DCR_{weld} = 87\%$

Maximum downward force at top of rail

$R_u := 1.0 \cdot R_{DL} + 1.0 \cdot R_{WL}$ $R_u = 3.135$ *kip*

Check if stiffeners are required for rail:

Steel Young's Modulus $E := 29000$ *ksi*

Yield strength of rail web $F_{yw} := 50$ *ksi*

Yield strength of rail flange $F_{yf} := 50$ *ksi*

Thickness of rail web $t_w := 0.245$ *in*

Thickness of rail flange $t_f := \frac{5}{16} \cdot in$

Distance from flange outer face to web toe of filletg $k := 0.615$ *in*

Length of Bearing $l_b := 4$ *in*

Section depth $d := 8$ *in*

Flange local bending capacity $\phi R_{n.fb} := 0.9 \cdot 6.25 \cdot F_{yf} \cdot t_f^{\,2}$ $\phi R_{n.fb} = 27.466$ *kip*

Demand-capacity-ratio $DCR_{fl.bend} := \frac{R_u}{\phi R_{n.fb}}$ $DCR_{fl.bend} = 11\%$

Web local Yielding capacity $\phi R_{n.wy} := F_{yw} \cdot t_w \cdot \left(2.5 \cdot k + l_b\right)$ $\phi R_{n.wy} = 67.8$ *kip*

Demand-capacity-ratio $DCR_{web.yield} := \frac{R_u}{\phi R_{n.wy}}$ $DCR_{web.yield} = 5\%$

Web local crippling capacity $\phi R_{n.wc} := 0.75 \cdot 0.4 \cdot t_w^{\,2} \cdot \left(1 + \left(4 \cdot \frac{l_b}{d} - 0.2\right) \cdot \left(\frac{t_w}{t_f}\right)^{1.5}\right) \cdot \sqrt{E \cdot F_{yw} \cdot \frac{t_f}{t_w}}$ $\phi R_{n.wc} = 55.1$ *kip*

Demand-capacity-ratio $DCR_{web.crp} := \frac{R_u}{\phi R_{n.wc}}$ $DCR_{web.crp} = 6\%$

Rail does not require web stiffeners and, by inspection, flanges of MC12x31 below (tf= 0.7", bf = 3.67") will also not require stiffeners.

Checking bending capacity of web of MC12x31

Yield strength of web $F_{yw} := 36\ ksi$

Thickness of web $t_w := \frac{3}{8} \cdot in$

Flat length of web $L_w := 9.375\ in$

Width of channel $b_w := 8\ in$

Moment capacity of web $\phi M_n := 0.9 \cdot F_{yw} \cdot \frac{b_w \cdot t_w^{\ 2}}{4}$ $\phi M_n = 0.759\ kip \cdot ft$

Point load to achieve moment capacity $\phi P_n := \frac{\phi M_n \cdot 4}{L_w}$ $\phi P_n = 3.888\ kip$

Demand-capacity-ratio $DCR_{channel} := \frac{R_u}{\phi P_n}$ $DCR_{channel} = 81\%$

Web of MC channel does not require stiffeners as long as the section is 8" long

Walter P Moore 633 West 5th St, Suite 7200 Los Angeles, CA, 90071	Project Fulton Center HVAC Improvements				Job Ref. D08.24014.00	
	Section RTU support rail				Sheet no./rev. 1	
	Calc. by RC	Date 6/1/2025	Chk'd by	Date	App'd by	Date

RAIL SUPPORTING RTU

In accordance with AISC360 15th Edition published 2016 using the LRFD method

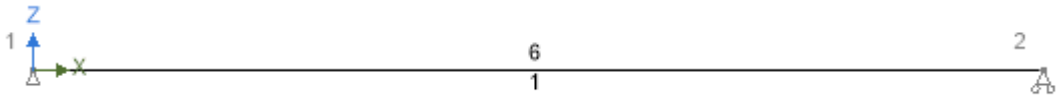
Tedds calculation version 4.5.00

ANALYSIS

Tedds calculation version 1.0.38

Geometry

Geometry (ft) - Steel (AISC) - W 8x15



Span	Length (ft)	Section	Start Support	End Support
1	6	W 8x15	Pinned	Roller Pin X
W 8x15: Area 4 in^2, Inertia Major 48 in^4, Inertia Minor 3 in^4, Shear area parallel to Minor 2 in^2, Shear area parallel to Major 2 in^2				
Steel (AISC): Density 490 lbm/ft^3, Youngs 29000 ksi, Shear 11200 ksi, Thermal 0.000012 $°C^{-1}$				

Loading

Self weight included

Dead - Loading (kips/ft)

Wind - Loading (kips/ft)

Load combination factors

Load combination	Self Weight	Dead	Wind
1.0D + 1.0L (Service)	1.00	1.00	
1.2D + 1.0L + 0.5Lr + 1.0W (Strength)	1.20	1.20	1.00
0.9D + 1.0W (Strength)	0.90	0.90	-1.00
0.6D + 0.6W (Service)	0.60	0.60	-0.60
1.4D (Strength)	1.40	1.40	

Member Loads

Member	Load case	Load Type	Orientation	Description
RTU RAIL	Dead	UDL	GlobalZ	0.15 kips/ft
RTU RAIL	Wind	UDL	GlobalZ	0.38 kips/ft

Results

Total deflection

Member results

Load combination: 1.0D + 1.0L (Service)

Member	Position (ft)	Deflection (in)		Axial deflection (in)	
RTU RAIL	0	0		0	
	3	0.004 (max)		0	
	6	0		0	

Member results

Load combination: 1.2D + 1.0L + 0.5Lr + 1.0W (Strength)

Member	Position (ft)	Deflection (in)		Axial deflection (in)	
RTU RAIL	0	0		0	
	3	0.013 (max)		0	
	6	0		0	

Member results

Load combination: 0.9D + 1.0W (Strength)

Member	Position (ft)	Deflection (in)		Axial deflection (in)	
RTU RAIL	0	0		0	
	3	-0.005 (min)		0	
	6	0		0	

Member results

Load combination: 0.6D + 0.6W (Service)

Member	Position (ft)	Deflection (in)		Axial deflection (in)	
RTU RAIL	0	0		0	
	3	-0.003 (min)		0	
	6	0		0	

Member results

Load combination: 1.4D (Strength)

Member	Position (ft)	Deflection (in)		Axial deflection (in)	
RTU RAIL	0	0		0	
	3	0.005 (max)		0	
	6	0		0	

Reactions

Load case: Self Weight

Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	0.045	0
2	0	0.045	0

Load case: Dead

Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	0.438	0
2	0	0.438	0

Load case: Wind

Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	1.125	0
2	0	1.125	0

Load combination: 1.0D + 1.0L (Service)

Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	0.483	0
2	0	0.483	0

Load combination: 1.2D + 1.0L + 0.5Lr + 1.0W (Strength)

Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	1.705	0
2	0	1.705	0

Load combination: 0.9D + 1.0W (Strength)

Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	-0.69	0
2	0	-0.69	0

Load combination: 0.6D + 0.6W (Service)

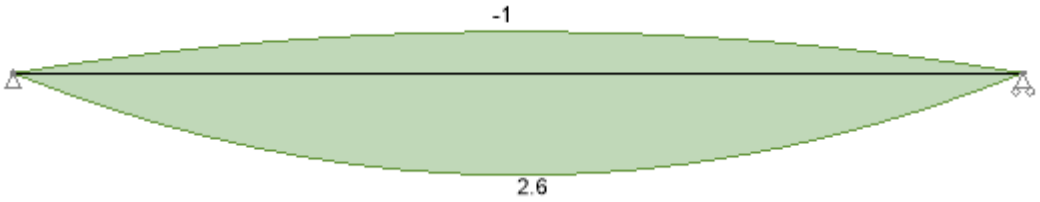
Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	-0.385	0
2	0	-0.385	0

Load combination: 1.4D (Strength)

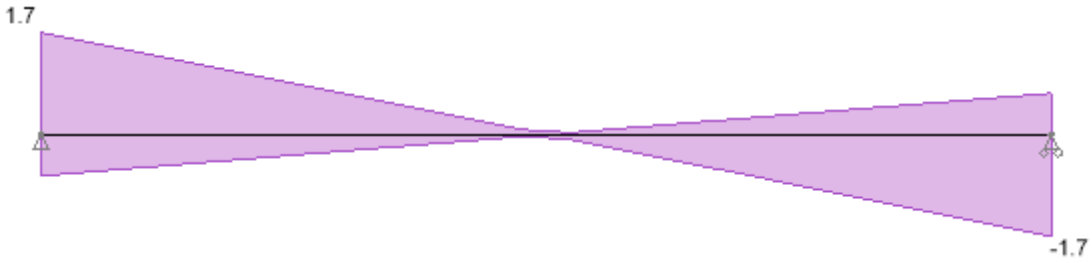
Node	Force		Moment
	Fx (kips)	Fz (kips)	My (kip_ft)
1	0	0.677	0
2	0	0.677	0

Forces

Strength combinations - Moment envelope (kip_ft)



Strength combinations - Shear envelope (kips)



Member results

Envelope - Strength combinations

Member	Position (ft)	Shear force (kips)		Moment (kip_ft)	
RTU RAIL	0	1.705 (max abs)	-0.69	0	
	3	0		2.557 (max)	-1.035 (min)
	6	0.69	-1.705	0	

Envelope - Service combinations

Member	Position (ft)	Deflection (in)	
RTU RAIL	3	0.004 (max)	-0.003 (min)

Member results

Load combination: 1.0D + 1.0L (Service)

Member	Position (ft)	Deflection (in)	
RTU RAIL	3	0.004 (max)	
	6	0	

Member results

Load combination: 1.2D + 1.0L + 0.5Lr + 1.0W (Strength)

Member	Position (ft)	Shear force (kips)		Moment (kip_ft)	
RTU RAIL	0	1.705 (max abs)		0 (min)	
	3	0		2.557 (max)	
	6	-1.705		0 (min)	

Member results

Load combination: 0.9D + 1.0W (Strength)

Member	Position (ft)	Shear force (kips)		Moment (kip_ft)	
RTU RAIL	0	-0.69		0 (max)	
	3	0		-1.035 (min)	
	6	0.69 (max abs)		0 (max)	

Member results

Load combination: 0.6D + 0.6W (Service)

Member	Position (ft)	Deflection (in)	
RTU RAIL	3	-0.003 (min)	
	6	0	

Member results

Load combination: 1.4D (Strength)

Member	Position (ft)	Shear force (kips)		Moment (kip_ft)	
RTU RAIL	0	0.677 (max abs)		0 (min)	
	3	0		1.015 (max)	
	6	-0.677		0 (min)	

Resistance factors

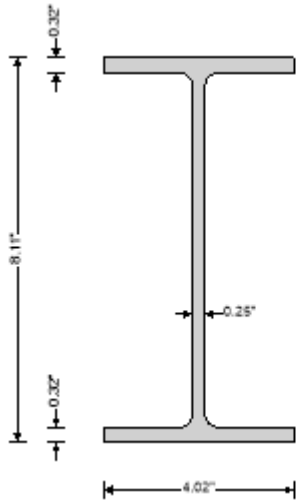
Shear	ϕ_v = **0.90**
Flexure	ϕ_b = **0.90**
Tensile yielding	$\phi_{t,y}$ = **0.90**
Tensile rupture	$\phi_{t,r}$ = **0.75**
Compression	ϕ_c = **0.90**

RTU RAIL design

Section details

Section type	W 8x15 (AISC 15th Edn (v15.0))
ASTM steel designation	A992
Steel yield stress	F_y = **50** ksi
Steel tensile stress	F_u = **65** ksi
Modulus of elasticity	E = **29000** ksi

Walter P Moore 633 West 5th St, Suite 7200 Los Angeles, CA, 90071	Project Fulton Center HVAC Improvements				Job Ref. D08.24014.00	
	Section RTU support rail				Sheet no./rev. 6	
	Calc. by RC	Date 6/1/2025	Chk'd by	Date	App'd by	Date



W 8x15 (AISC 15th Edn (v15.0))
Section depth, d, 8.11 in
Section breadth, b_f, 4.02 in
Weight of section, Weight, 15 lbf/ft
Flange thickness, t_f, 0.315 in
Web thickness, t_w, 0.245 in
Root radius, k - t_f, 0.3 in
Area of section, A, 4.4 in^2
Radius of gyration about x-axis, r_x, 3.29 in
Radius of gyration about y-axis, r_y, 0.876 in
Elastic section modulus about x-axis, S_x, 11.8 in^3
Elastic section modulus about y-axis, S_y, 1.7 in^3
Plastic section modulus about x-axis, Z_x, 13.6 in^3
Plastic section modulus about y-axis, Z_y, 2.67 in^3
Second moment of area about x-axis, I_x, 48 in^4
Second moment of area about y-axis, I_y, 3.41 in^4

RTU RAIL results summary	Unit	Capacity	Maximum	Utilization	Result

Lateral restraint

Both flanges have lateral restraint at supports only

Consider Combination 2 - 1.2D + 1.0L + 0.5Lr + 1.0W (Strength)

Classification of sections for local buckling - Section B4

Classification of flanges in flexure - Table B4.1b (case 10)

Width to thickness ratio $b_f / (2 \times t_f)$ = **6.38**

Limiting ratio for compact section $\lambda_{pff} = 0.38 \times \sqrt{[E / F_y]}$ = **9.15**

Limiting ratio for non-compact section $\lambda_{rff} = 1.0 \times \sqrt{[E / F_y]}$ = **24.08** Compact

Classification of web in flexure - Table B4.1b (case 15)

Width to thickness ratio $(d - 2 \times k) / t_w$ = **28.08**

Limiting ratio for compact section $\lambda_{pwf} = 3.76 \times \sqrt{[E / F_y]}$ = **90.55**

Limiting ratio for non-compact section $\lambda_{rwf} = 5.70 \times \sqrt{[E / F_y]}$ = **137.27** Compact

Section is compact in flexure

Check design 3ft along span

Design of members for flexure - Chapter F

Required flexural strength $M_{r,x}$ = **2.6** kips_ft

Yielding - Section F2.1

Nominal flexural strength for yielding - eq F2-1 $M_{n,yld,x} = M_{p,x} = F_y \times Z_x$ = **56.7** kips_ft

Lateral-torsional buckling - Section F2.2

Unbraced length L_b = **6** ft

Limiting unbraced length for yielding - eq F2-5 $L_p = 1.76 \times r_y \times \sqrt{(E / F_y)}$ = **3.094** ft

Distance between flange centroids	h_o = **7.8** in
	c = **1**
	r_{ts} = **1.06** in
Limiting unbraced length for inelastic LTB - eq F2-6	$L_r = 1.95 \times r_{ts} \times E / (0.7 \times F_y) \times \sqrt{((J \times c / (S_x \times h_o)) + \sqrt{((J \times c / (S_x \times h_o))^2 + 6.76 \times (0.7 \times F_y / E)^2)}}$ = **10.053** ft
Moment at quarter point of segment	M_A = **1.9** kips_ft
Moment at center-line of segment	M_B = **2.6** kips_ft
Moment at three quarter point of segment	M_C = **1.9** kips_ft
Maximum moment in segment	M_{max} = **2.6** kips_ft
LTB modification factor - eq F1-1	$C_b = 12.5 \times M_{max} / (2.5 \times M_{max} + 3 \times M_A + 4 \times M_B + 3 \times M_C)$ = **1.136**
Nominal flexural strength for lateral-torsional buckling - eq F2-2	
	$M_{n,ltb,x} = \min(C_b \times (M_{p,x} - (M_{p,x} - 0.7 \times F_y \times S_x) \times (L_b - L_p) / (L_r - L_p)), M_{p,x})$ = **53.8** kips_ft

Design flexural strength - F1

Nominal flexural strength	$M_{n,x} = \min(M_{n,yld,x}, M_{n,ltb,x})$ = **53.8** kips_ft
Design flexural strength	$M_{c,x} = \phi_b \times M_{n,x}$ = **48.5** kips_ft
	$M_{r,x} / M_{c,x}$ = **0.053**
	PASS - Design flexural strength exceeds required flexural strength

Consider Combination 1 - 1.0D + 1.0L (Service)

Check design 3ft along span

Design of members for x-x axis deflection

Maximum deflection	δ_x = **0.004** in
Allowable deflection	$\delta_{x,Allowable} = L_{m1_s1} / 360$ = **0.2** in
	$\delta_x / \delta_{x,Allowable}$ = **0.019**
	PASS - Allowable deflection exceeds design deflection

CHECK OF LADDER ATTACHMENT TO CMU WALL

www.hilti.com

Company:	Walter P Moore	Page:	1
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**HY 270 + threaded rod F1554 Gr.55 3/4**
Item number:	2197983 HAS-E-55 3/4"x8" (element) / 2194247 HIT-HY 270 (adhesive)
Specification text:	Hilti ∅ 3/4 HY 270 + threaded rod F1554 Gr.55 with 6.75 in nominal embedment depth per Technical data , Hammer drilled installation per MPII,
Effective embedment depth:	h_{ef} = 6.750 in.
Material:	ASTM F 1554
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ASD Masonry
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate[R] :	l_x x l_y x t = 3.000 in. x 3.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	Grout-filled CMU, L x W x H: 16.000 in. x 8.000 in. x 8.000 in.;
	Joints: vertical: 0.375 in.; horizontal: 0.375 in.; Head (vertical) joints are completely filled with grout or mortar
	Base material temperature: 68 °F
Installation:	Face installation
Seismic loads	no

Check of threaded rod in bending:

phi_Mn = 0.9*55 ksi* 0.75^3/6 = 3.48 kip-in

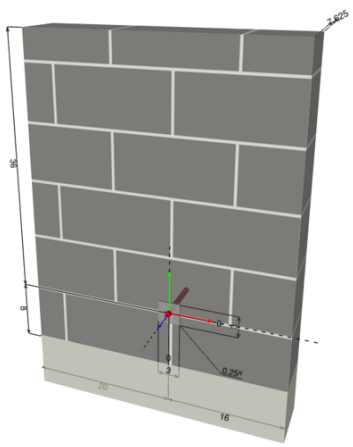
Corresponding Shear (with 6" arm)
phi_Vn = phi_Mn/6" = 0.58 kip

Load demand: Vu = 0.3 kip

DCR in bending: Vu/phi_Vn = 52 % OK

[R] - The anchor calculation is based on a rigid anchor plate assumption.

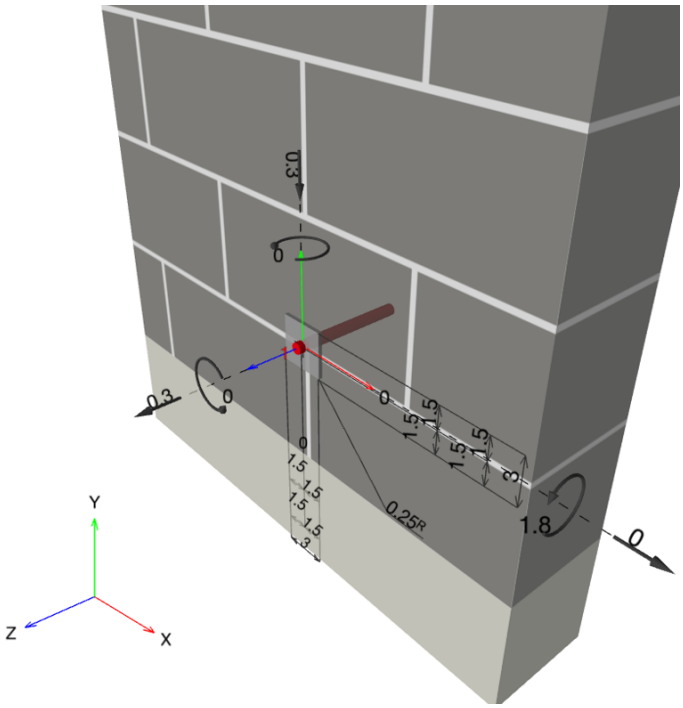
Geometry [in.]



Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	2
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

Geometry [in.] & Loading [kip, in.kip]

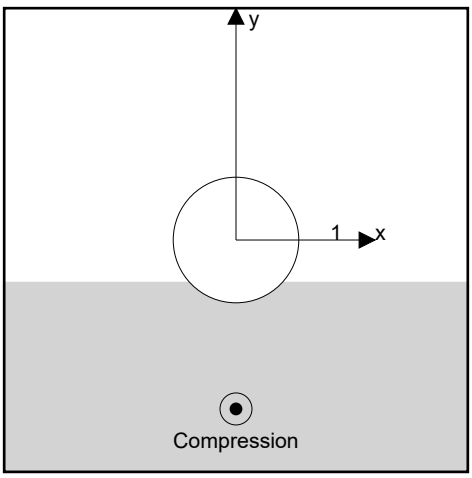


1.1 Design results

Case	Description	Forces [kip] / Moments [in.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0.300; V_x = 0.000; V_y = -0.300; M_x = 1.800000; M_y = 0.000000; M_z = 0.000000;	no	96

2 Load case/Resulting anchor forces

Load case: Service loads



Anchor reactions [kip]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1.947	0.300	0.000	-0.300

max. compressive strain:	0.67 [‰]
max. compressive stress:	899 [psi]
Resulting tension force in (x/y)=(0.000/0.000):	1.947 [kip]
Resulting compression force in (x/y)=(0.000/-1.093):	1.647 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	3
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

3 Tension load (Most utilized anchor 1)

	Load P_s [kip]	Capacity P_t [kip]	Utilization $\beta_P = P_s/P_t$ [%]	Status
Steel strength	1.947	10.935	18	OK
Bond strength	1.947	2.597	75	OK

3.1 Steel strength

$P_{t,s}$ = Value refer to Hilti Technical Data
$P_{t,s} \geq P_s$

Results

$P_{t,s}$ [kip]	P_s [kip]
10.935	1.947

3.2 Bond strength

$P_{t,b,Base}$ = Value refer to Hilti Technical Data
$P_{t,b} = P_{t,b,Base} \cdot f_{red,E} \cdot f_{red,s} \cdot f_{red,Temp} \cdot f_{red,Bedjoint}$
$P_{t,b} \geq P_s$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
4.000	20.000	4.000	27.000	68

Results

$P_{t,b}$ [kip]	$P_{t,b,Base}$ [kip]	P_s [kip]	$f_{red,E}$	$f_{red,S}$	$f_{red,Temp}$	$f_{red,Bedjoint}$
2.597	3.810	1.947	0.682	1.000	1.000	1.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	4
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

4 Shear load (Most utilized anchor 1)

	Load V_s [kip]	Capacity V_t [kip]	Utilization $\beta_V = V_s/V_t$ [%]	Status
Steel strength	0.300	5.635	6	OK
Bond strength para and perp, (Dir. y-)[1]	-	-	21	OK

[1]Shear utilization may result from parallel and perpendicular shear (see details)

4.1 Steel strength

$V_{t,s}$ = Value refer to Hilti Technical Data
$V_{t,s} \geq V_s$

Results

$V_{t,s}$ [kip]	V_s [kip]
5.635	0.300

4.2 Bond strength parallel

$V_{t,b,Base,||}$ = Value refer to Hilti Technical Data
$V_{t,b,||} = V_{t,b,Base,||} \cdot f_{red,E,||} \cdot f_{red,s,||} \cdot f_{red,Temp}$
$V_{t,b,||} \geq V_{s,||}$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
4.000	20.000	4.000	27.000	68

Results

$V_{t,b,\|\|}$ [kip]	$V_{t,b,Base,\|\|}$ [kip]	$V_{s,\|\|}$ [kip]	$f_{red,E,\|\|}$	$f_{red,S,\|\|}$	$f_{red,Temp}$	Utilization $\beta_{V,\|\|}$ [%]
0.000	4.090	0.000	0.000	0.000	1.000	0

4.3 Bond strength perpendicular

$V_{t,b,Base,\perp}$ = Value refer to Hilti Technical Data
$V_{t,b,\perp} = V_{t,b,Base,\perp} \cdot f_{red,E,\perp} \cdot f_{red,s,\perp} \cdot f_{red,Temp}$
$V_{t,b,\perp} \geq V_{s,\perp}$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
4.000	20.000	4.000	27.000	68

Results

$V_{t,b,\perp}$ [kip]	$V_{t,b,Base,\perp}$ [kip]	$V_{s,\perp}$ [kip]	$f_{red,E,\perp}$	$f_{red,S,\perp}$	$f_{red,Temp}$	Utilization $\beta_{V,\perp}$ [%]
1.483	4.090	-0.300	0.363	1.000	1.000	20

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	5
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

4.4 Shear interaction

$\beta_{V,\parallel} = \frac{V_{s,\parallel}}{V_{t,\parallel}}$	$\beta_{V,\perp} = \frac{V_{s,\perp}}{V_{t,\perp}}$	δ	Utilization β_V [%]	Status
0.000	0.202	1.000	21	OK

$\beta_V = \beta_{V,\parallel}^{\delta} + \beta_{V,\perp}^{\delta} <= 1.0$

5 Combined tension and shear loads (Most utilized anchor 1)

$\beta_P = \frac{P_s}{P_t}$	$\beta_{V,\parallel} = \frac{V_{s,\parallel}}{V_{t,\parallel}}$	$\beta_{V,\perp} = \frac{V_{s,\perp}}{V_{t,\perp}}$	α	Utilization $\beta_{P,V}$ [%]	Status
0.750	0.000	0.202	1.000	96	OK

$\beta_{P,V} = \beta_P^{\alpha} + \beta_{V,\parallel}^{\alpha} + \beta_{V,\perp}^{\alpha} <= 1.0$

6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- The min. sizes of the bricks, the masonry compressive strength, the type / strength of the mortar and the grout (in case of fully grouted CMU walls) has to fulfill the requirements given in the relevant ESR-approval or in the PTG.
- Only the local load transfer from the anchor(s) to the wall is considered, a further load transfer in the wall is not covered by PROFIS!
- Wall is assumed as being perfectly aligned vertically – checking required(!): Noncompliance can lead to significantly different distribution of forces and higher tension loads than those calculated by PROFIS. Masonry wall must not have any damages (neither visible nor not visible)! While installation, the positioning of the anchors needs to be maintained as in the design phase i.e. either relative to the brick or relative to the mortar joints.
- The effect of the joints on the compressive stress distribution on the plate / bricks was not taken into consideration.
- If no significant resistance is felt over the entire depth of the hole when drilling (e.g. in unfilled butt joints), the anchor should not be set at this position or the area should be assessed and reinforced. Hilti recommends the anchoring in masonry always with sieve sleeve. Anchors can only be installed without sieve sleeves in solid bricks when it is guaranteed that it has not any hole or void.
- The accessories and installation remarks listed on this report are for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- The compliance with current standards (e.g. 2018, 2015, 2012, 2009 and 2006 IBC) is the responsibility of the user.
- Drilling method (hammer, rotary) to be in accordance with the approval!
- Masonry should be built according to industry standards.

Fastening meets the design criteria!

PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	6
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.812 in.

Plate thickness (input): 0.250 in.

Drilling method: Drilled in hammer mode

Anchor type and diameter: HY 270 + threaded rod F1554 Gr.55 3/4

Item number: 2197983 HAS-E-55 3/4"x8" (element) / 2194247 HIT-HY 270 (adhesive)

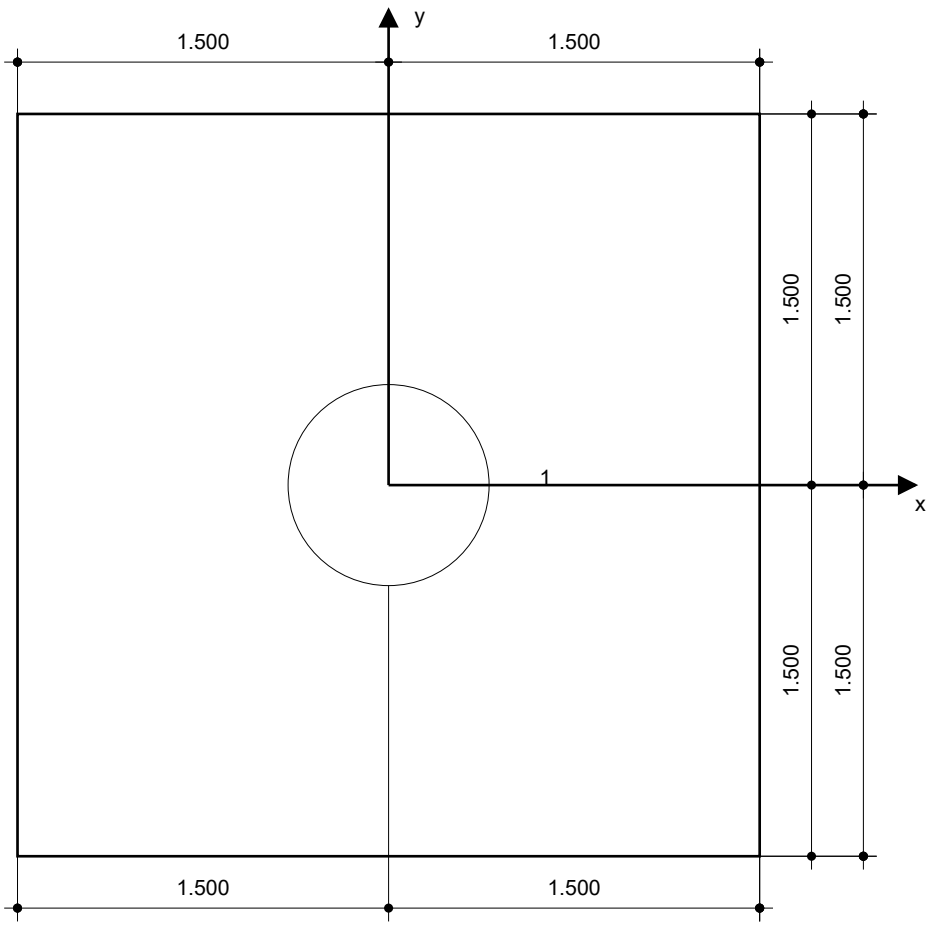
Maximum installation torque: 0.120000 in.kip

Hole diameter in the base material: 0.875 in.

Hole depth in the base material: 6.750 in.

Minimum thickness of the base material: 7.625 in.

Hilti ∅ 3/4 HY 270 + threaded rod F1554 Gr.55 with 6.75 in nominal embedment depth per Technical data , Hammer drilled installation per MPII



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	0.000	20.000	16.000	8.000	36.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	7
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall face	Date:	6/1/2025
Fastening point:			

8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

www.hilti.com

Company:	Walter P Moore	Page:	1
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

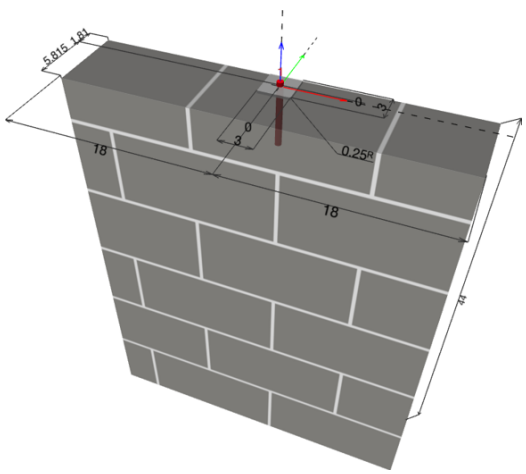
Specifier's comments:

1 Input data

Anchor type and diameter:	**HY 270 + threaded rod F1554 Gr.55 5/8**
Item number:	2197995 HAS-E-55 5/8"x8" (element) / 2194247 HIT-HY 270 (adhesive)
Specification text:	Hilti ∅ 5/8 HY 270 + threaded rod F1554 Gr.55 with 5.625 in nominal embedment depth per Technical data , Hammer drilled installation per MPII,
Effective embedment depth:	h_{ef} = 5.625 in.
Material:	ASTM F 1554
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ASD Masonry
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate[R]:	l_x x l_y x t = 3.000 in. x 3.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	Grout-filled CMU, L x W x H: 16.000 in. x 8.000 in. x 8.000 in.; Joints: vertical: 0.375 in.; horizontal: 0.375 in. Base material temperature: 68 °F
Installation:	Top installation
Seismic loads	no

[R] - The anchor calculation is based on a rigid anchor plate assumption.

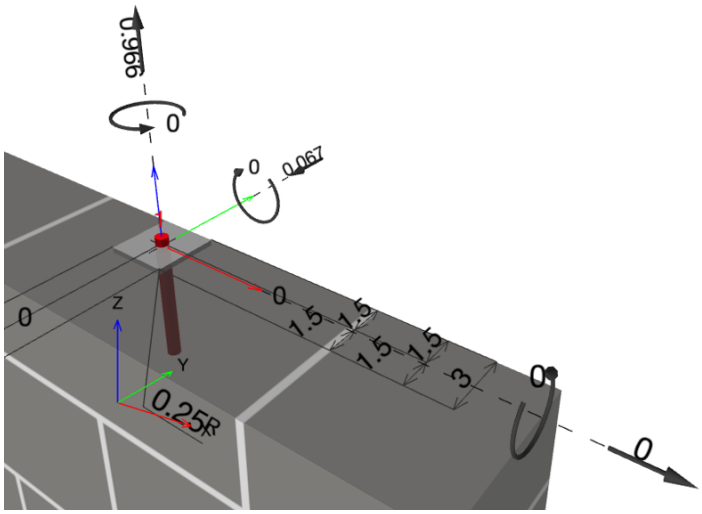
Geometry [in.]



Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	2
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

Geometry [in.] & Loading [kip, in.kip]

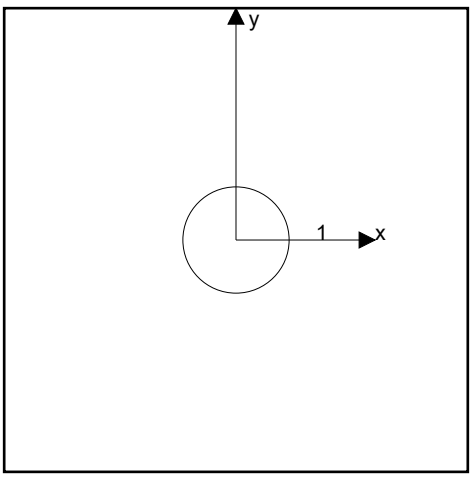


1.1 Design results

Case	Description	Forces [kip] / Moments [in.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0.966; V_x = 0.000; V_y = -0.067; M_x = 0.000000; M_y = 0.000000; M_z = 0.000000;	no	93

2 Load case/Resulting anchor forces

Load case: Service loads



Anchor reactions [kip]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0.966	0.067	0.000	-0.067

max. compressive strain: - [‰]
max. compressive stress: - [psi]
Resulting tension force in (x/y)=(0.000/0.000): 0.966 [kip]
Resulting compression force in (x/y)=(-/-): 0.000 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	3
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

3 Tension load (Most utilized anchor 1)

	Load P_s [kip]	Capacity P_t [kip]	Utilization $\beta_P = P_s/P_t$ [%]	Status
Steel strength	0.966	7.595	13	OK
Bond strength	0.966	1.176	83	OK

3.1 Steel strength

$P_{t,s}$ = Value refer to Hilti Technical Data
$P_{t,s} \geq P_s$

Results

$P_{t,s}$ [kip]	P_s [kip]
7.595	0.966

3.2 Bond strength

$P_{t,b,Base}$ = Value refer to Hilti Technical Data
$P_{t,b} = P_{t,b,Base} \cdot f_{red,E} \cdot f_{red,s} \cdot f_{red,Temp}$
$P_{t,b} \geq P_s$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
1.750	4.000	3.000	16.000	68

Results

$P_{t,b}$ [kip]	$P_{t,b,Base}$ [kip]	P_s [kip]	$f_{red,E}$	$f_{red,S}$	$f_{red,Temp}$
1.176	1.590	0.966	0.740	1.000	1.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	4
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

4 Shear load (Most utilized anchor 1)

	Load V_s [kip]	Capacity V_t [kip]	Utilization $\beta_V = V_s/V_t$ [%]	Status
Steel strength	0.067	3.910	2	OK
Bond strength para and perp, (Dir. y-)[1]	-	-	11	OK

[1]Shear utilization may result from parallel and perpendicular shear (see details)

4.1 Steel strength

$V_{t,s}$ = Value refer to Hilti Technical Data
$V_{t,s} \geq V_s$

Results

$V_{t,s}$ [kip]	V_s [kip]
3.910	0.067

4.2 Bond strength parallel

$V_{t,b,Base,||}$ = Value refer to Hilti Technical Data
$V_{t,b,||} = V_{t,b,Base,||} \cdot f_{red,E,||} \cdot f_{red,s,||} \cdot f_{red,Temp}$
$V_{t,b,||} \geq V_{s,||}$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
1.750	4.000	3.000	16.000	68

Results

$V_{t,b,\|\|}$ [kip]	$V_{t,b,Base,\|\|}$ [kip]	$V_{s,\|\|}$ [kip]	$f_{red,E,\|\|}$	$f_{red,S,\|\|}$	$f_{red,Temp}$	Utilization $\beta_{V,\|\|}$ [%]
0.000	1.825	0.000	0.000	0.000	1.000	0

4.3 Bond strength perpendicular

$V_{t,b,Base,\perp}$ = Value refer to Hilti Technical Data
$V_{t,b,\perp} = V_{t,b,Base,\perp} \cdot f_{red,E,\perp} \cdot f_{red,s,\perp} \cdot f_{red,Temp}$
$V_{t,b,\perp} \geq V_{s,\perp}$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
1.750	4.000	3.000	16.000	68

Results

$V_{t,b,\perp}$ [kip]	$V_{t,b,Base,\perp}$ [kip]	$V_{s,\perp}$ [kip]	$f_{red,E,\perp}$	$f_{red,S,\perp}$	$f_{red,Temp}$	Utilization $\beta_{V,\perp}$ [%]
0.655	0.655	-0.067	1.000	1.000	1.000	10

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	5
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

4.4 Shear interaction

$\beta_{V,\parallel} = \frac{V_{s,\parallel}}{V_{t,\parallel}}$	$\beta_{V,\perp} = \frac{V_{s,\perp}}{V_{t,\perp}}$	δ	Utilization β_V [%]	Status
0.000	0.102	1.000	11	OK

$\beta_V = \beta_{V,\parallel}^{\delta} + \beta_{V,\perp}^{\delta} <= 1.0$

5 Combined tension and shear loads (Most utilized anchor 1)

$\beta_P = \frac{P_s}{P_t}$	$\beta_{V,\parallel} = \frac{V_{s,\parallel}}{V_{t,\parallel}}$	$\beta_{V,\perp} = \frac{V_{s,\perp}}{V_{t,\perp}}$	α	Utilization $\beta_{P,V}$ [%]	Status
0.821	0.000	0.102	1.000	93	OK

$\beta_{P,V} = \beta_P^{\alpha} + \beta_{V,\parallel}^{\alpha} + \beta_{V,\perp}^{\alpha} <= 1.0$

6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- The min. sizes of the bricks, the masonry compressive strength, the type / strength of the mortar and the grout (in case of fully grouted CMU walls) has to fulfill the requirements given in the relevant ESR-approval or in the PTG.
- Only the local load transfer from the anchor(s) to the wall is considered, a further load transfer in the wall is not covered by PROFIS!
- Wall is assumed as being perfectly aligned vertically – checking required(!): Noncompliance can lead to significantly different distribution of forces and higher tension loads than those calculated by PROFIS. Masonry wall must not have any damages (neither visible nor not visible)! While installation, the positioning of the anchors needs to be maintained as in the design phase i.e. either relative to the brick or relative to the mortar joints.
- The effect of the joints on the compressive stress distribution on the plate / bricks was not taken into consideration.
- If no significant resistance is felt over the entire depth of the hole when drilling (e.g. in unfilled butt joints), the anchor should not be set at this position or the area should be assessed and reinforced. Hilti recommends the anchoring in masonry always with sieve sleeve. Anchors can only be installed without sieve sleeves in solid bricks when it is guaranteed that it has not any hole or void.
- The accessories and installation remarks listed on this report are for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- The compliance with current standards (e.g. 2018, 2015, 2012, 2009 and 2006 IBC) is the responsibility of the user.
- Drilling method (hammer, rotary) to be in accordance with the approval!
- Masonry should be built according to industry standards.

Fastening meets the design criteria!

PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	6
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

7 Installation data

Anchor type and diameter: HY 270 + threaded rod F1554 Gr.55 5/8

Profile: no profile

Item number: 2197995 HAS-E-55 5/8"x8" (element) / 2194247 HIT-HY 270 (adhesive)

Hole diameter in the fixture: d_f = 0.687 in.

Maximum installation torque: 0.090000 in.kip

Plate thickness (input): 0.250 in.

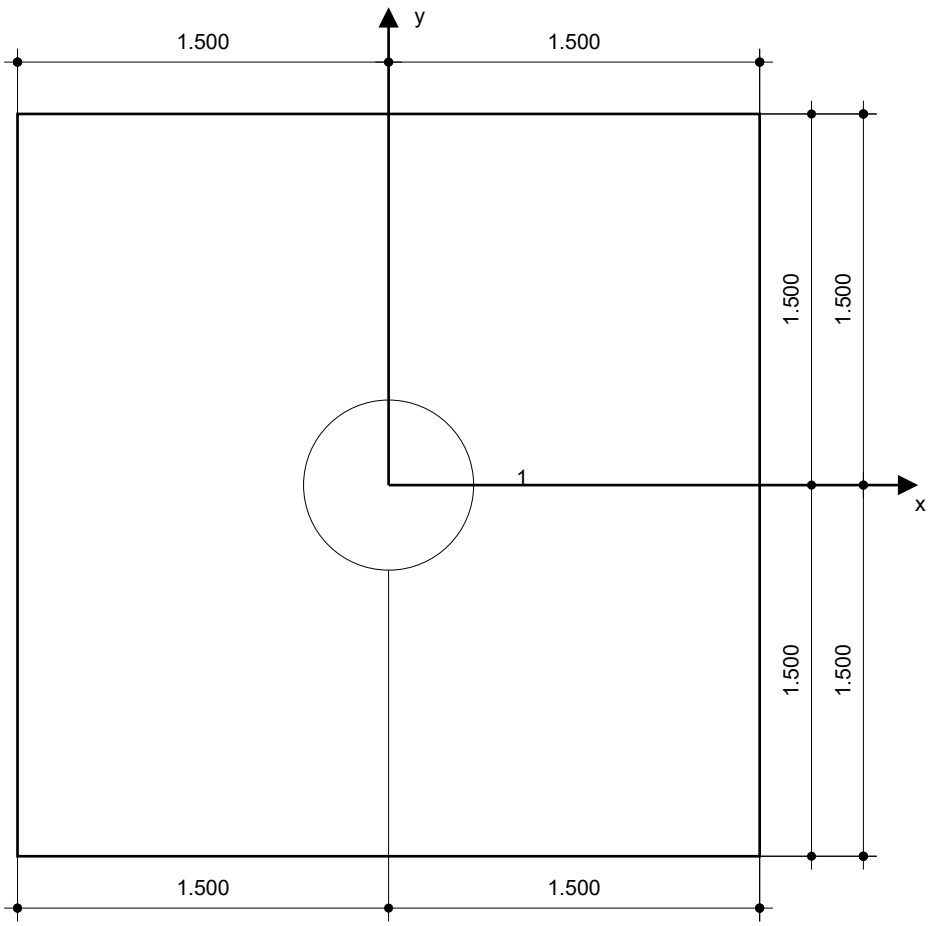
Hole diameter in the base material: 0.750 in.

Hole depth in the base material: 5.625 in.

Drilling method: Drilled in hammer mode

Minimum thickness of the base material: 7.625 in.

Hilti ∅ 5/8 HY 270 + threaded rod F1554 Gr.55 with 5.625 in nominal embedment depth per Technical data , Hammer drilled installation per MPII



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	0.000	18.000	18.000	5.815	1.810

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:	Walter P Moore	Page:	7
Address:	633 W 5th St, Suite 7200	Specifier:	Rodrigo Carreno
Phone I Fax:	2136944781 |	E-Mail:	rcarreno@walterpmoore.com
Design:	Ladder attachment to wall top	Date:	6/1/2025
Fastening point:			

8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2025 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

DESIGN OF LINTEL ABOVE NEW OPENING IN BUILDING K

walter p moore

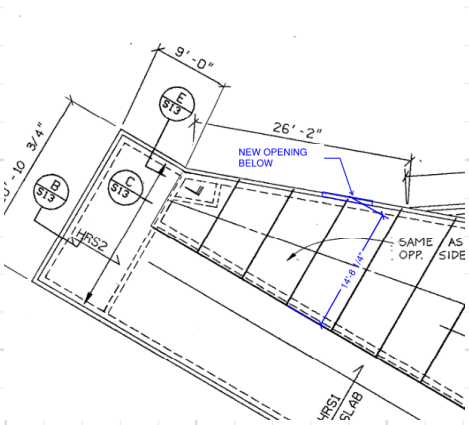
JOB NAME: Fulton Center HVAC Improvements
JOB NO.: 208.2404-00 DATE: 09/25/25
ENGINEER: R. Carenp DWG. REF.:
TAB NO.: SHEET NO.:

Lintel above new opening on Building K.

Load Takeoff:

Roof Level:

Dead load (DL): 30 psf
Live load (Lr): 20 psf
Tributary width: 7'-4"



Mezzanine Level:

Dead load (DL): $13.33\,ft \times (30\,psf + 40\,psf) = 1.64\,klf$

8" CMU fully grouted
4" brick veneer.

Design load on lintel:

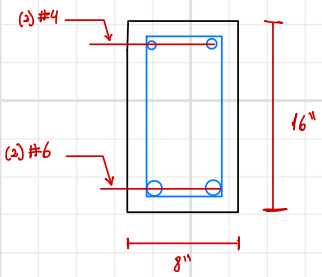
$$w_u = 1.2(30 \cdot 7.33 + 1640) + 1.6 \cdot 20 \cdot 7.33$$

$$w_u = 2.47\ klf$$

$$M_u = \frac{w_u l^2}{8} = \frac{2.47 \cdot 6^2}{8} = 11.11\ kip\text{-}ft$$

$$V_u = \frac{w_u \cdot l}{2} = \frac{2.47 \cdot 6}{2} = 7.41\ kip$$

Beam design calculations performed on Tedds (see following Pages)



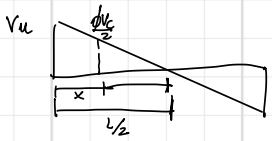
$\frac{M_u}{\phi M_n} = 21.8\ \%$ OK

$\frac{V_u}{\phi V_c} = 88.6\ \%$ OK

Since $V_u \geq \frac{\phi V_c}{2}$ minimum reinf is required.

Location to interrupt stirrups: $\frac{V_u}{l/2} = \frac{\frac{\phi V_c}{2}}{l/2 - x}$

$x = 1.3\ ft.$



Walter P Moore 633 West 5th St, Suite 7200 Los Angeles, CA, 90071	Project Fulton HVAC Improvements				Job Ref. D08.24014-00	
	Section				Sheet no./rev. 1	
	Calc. by RC	Date 9/25/2025	Chk'd by	Date	App'd by	Date

RC BEAM DESIGN (ACI318-2019 (22))

In accordance with ACI318-2019 (22)

Tedds calculation version 3.3.18

Concrete details

Compressive strength of concrete	f'_c = **4000** psi
Density of reinforced concrete	w_c = **150** lb / ft^3
Concrete type	Normal weight
Modulus of elasticity of concrete (cl.19.2.2.1)	$E = (w_c / 1\ lb/ft^3)^{1.5} \times 33\ psi \times (f'_c / 1\ psi)^{0.5}$ = **3834254** psi
Strength reduction factor for shear	ϕ_s = **0.75**

Reinforcement details

Yield strength of reinforcement	f_y = **60000** psi
Compression-controlled strain limit (cl.21.2.2.1)	ε_{ty} = **0.00200**

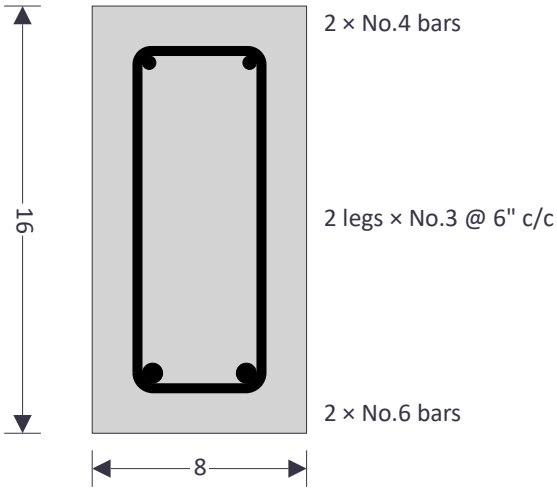
Nominal cover to reinforcement

Cover to top reinforcement	c_{nom_t} = **1.5** in
Cover to bottom reinforcement	c_{nom_b} = **1.5** in
Cover to side reinforcement	c_{nom_s} = **1.5** in

Section 1 - Lintel Above new Louver Opening

Rectangular section details

Section width	b = **8** in
Section depth	h = **16** in



Positive moment. Rectangular section in flexure (Section 9.5.2)

Factored bending moment at section	$M_u = M_{pos_s1}$ = **11.110** kip_ft
Effective depth to tension reinforcement	d = **13.75** in
Tension reinforcement provided	2 × No.6 bars
Area of tension reinforcement provided	$A_{s,prov}$ = **0.884** in^2
Minimum area of reinforcement (cl.9.6.1.2)	$A_{s,min} = \max(3\ psi \times \sqrt{(f'_c / 1\ psi)}, 200\ psi) \times b \times d / f_y$ = **0.367** in^2

PASS - Area of reinforcement provided is greater than minimum area of reinforcement required

Stress block depth factor (cl.22.2.2.4.3)	$\beta_1 = \min(\max(0.85 - 0.05 \times (f'_c - 4\ ksi) / 1\ ksi, 0.65), 0.85)$ = **0.85**

Depth of equivalent rectangular stress block	$a = A_{s,prov} \times f_y / (0.85 \times f'_c \times b)$ = **1.949** in
Depth to neutral axis	$c = a / \beta_1$ = **2.293** in
Net tensile strain in extreme tension fibers	$\varepsilon_t = 0.003 \times (d_o - c) / \max(c, 0.001\text{ in})$ = **0.01499**
	Net tensile strain in tension controlled zone
Strength reduction factor (cl.21.2.1)	$\phi_f = \min(\max(0.65 + 0.25 \times (\varepsilon_t - \varepsilon_{ty}) / (0.003), 0.65), 0.9)$ = **0.90**
Nominal moment strength	$M_n = A_{s,prov} \times f_y \times (d - a / 2)$ = **56.440** kip_ft
Design moment strength	$\phi M_n = M_n \times \phi_f$ = **50.796** kip_ft
	PASS - Required moment strength is less than design moment strength

Flexural cracking

Max. center to center spacing of tension reinf.	$s_{b,max} = s_{bot} + \phi_{s1_b_L1}$ = **3.500** in
Service load stress in reinforcement (cl.24.3.2)	$f_s = 2/3 \times f_y$ = **40000** psi
Clear cover of reinforcement	$c_c = c_{nom_b} + \phi_v$ = **1.875** in
Maximum allowable bot bar spacing (Table 24.3.2)	$s_{max} = \min(15\text{in} \times 40000\text{psi} / f_s - 2.5 \times c_c, 12\text{in} \times 40000\text{psi} / f_s)$ = **10.313** in
	PASS - Maximum allowable tension reinforcement spacing exceeds actual spacing

Spacing limits for reinforcement

Top bar clear spacing	$s_{top} = (b - (2 \times (c_{nom_s} + \phi_{s1_v}) + \phi_{s1_t_L1} \times N_{s1_t_L1})) / (N_{s1_t_L1} - 1)$ = **3.250** in
Min. allowable top bar clear spacing (cl.25.2.1)	$s_{top,min}$ = **1.000** in
Bottom bar clear spacing	$s_{bot} = (b - (2 \times (c_{nom_s} + \phi_{s1_v}) + \phi_{s1_b_L1} \times N_{s1_b_L1})) / (N_{s1_b_L1} - 1)$ = **2.750** in
Min. allowable bottom bar clear spacing (cl.25.2.1)	$s_{bot,min}$ = **1.000** in
	PASS - Actual bar spacing exceeds minimum allowable

Rectangular section in shear

Design shear force	V_u = **7.410** kips
Concrete weight modification factor	λ = **1.00**
Size effect factor (cl. 22.5.5.1.3)	$\lambda_s = \min(\sqrt{(2 / (1 + (d / 1\text{ in}) / 10))}, 1.0)$ = **0.92**
Area of longitudinal reinforcement	A_{st} = **0.884** in^2
Ratio of longitudinal reinforcement	$\rho_w = A_{st} / (b \times d)$ = **0.008**
Concrete shear strength (Table 22.5.5.1)	$\phi V_c = \phi_s \times \min(8 \times \lambda \times (\rho_w)^{1/3}, 5 \times \lambda) \times \sqrt{(f'_c \times 1\text{ psi})} \times b \times d$ = **8.360** kips
Reinforcement shear strength (eqn. 22.5.1.1)	$\phi V_s = \max(V_u - \phi V_c, 0\text{ kips})$ = **0.000** kips
Maximum reinforcement shear strength	$\phi V_{s,max} = \phi_s \times 8\text{ psi} \times \sqrt{(\min(f'_c, 10000\text{psi}) / 1\text{ psi})} \times b \times d$ = **41.742** kips
Area of design shear reinf. reqd (eqn. 22.5.8.5.3)	$A_{sv,des} = \phi V_s / (\phi_s \times \min(f_y, 60000\text{ psi}) \times d)$ = **0.000** in^2/ft
Min area of shear reinforcement (Table 9.6.3.4)	$A_{sv,min} = \max(50\text{ psi}, 0.75\text{ psi} \times \sqrt{(f'_c / 1\text{ psi})}) \times b / \min(f_y, 60000\text{ psi})$ = **0.080** in^2/ft
	ϕV_c >= V_u >= ϕV_c/2 - minimum reinforcement required
Area of shear reinforcement required	$A_{sv,req} = A_{sv,min}$ = **0.080** in^2/ft
Shear reinforcement provided	2 legs × No.3 @ 6" c/c
Area of shear reinforcement provided	$A_{sv,prov}$ = **0.442** in^2/ft
	PASS - Area of shear reinforcement provided exceeds area of shear reinforcement required
Maximum longitudinal spacing (Table 9.7.6.2.2)	$s_{vl,max} = \min(d / 2, 24\text{ in})$ = **6.875** in
	PASS - longitudinal spacing of stirrups is less than the maximum allowable

WALTER P MOORE
STRUCTURAL ENGINEERS

Contact Help Desk

Job Name:	Single Angle	**Revision No.:**	
Job No.:	Fulton HVAC	**Date:**	07/07/26
Engineer:	RC	**Sheet No.:**	1/1
Dwg. Ref.:	A1	**Tab No.:**	1

Loading Criteria

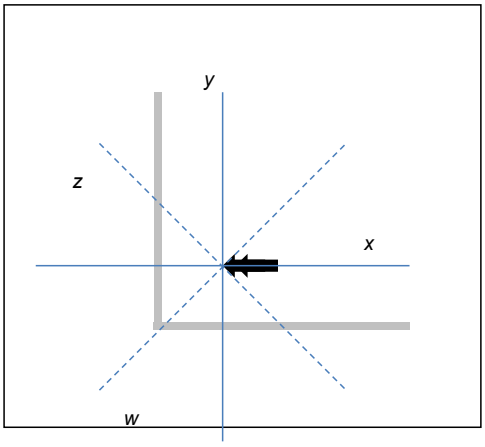
Angle	L4X4X1/4
Type of Lateral-torsional restraint along the length of the member?	No Restraint
Loading direction is parallel to which leg?	Long
Tip of Angle Leg in loading direction is in Compression or in Tension	Compression
Applied Moment about the loading axis, Mu	13.50 k-in.
Applied Shear, Vu	1.02 kips.
Eccentricity (for Torsion Tu = Vu x e)	2.00 in.
C_b	1.00
Unbraced length, l	72.00 in.

Material Properties

Specified minimum yield strength	36 ksi.

Member Properties

K_{xy}	-1.815 in.
I_z	1.2 in.
I_w	4.8 in.
β_w	1.00



Analysis Result

Flexural Demand/Capacity Ratio	**0.40**
Applied Moment, Mu	13.50 k-in.
Moment Capacity, ϕMn	33.90 k-in.

Applied Shear Stress/Ultimate Shear Stress Ratio	**0.67**
Applied Shear Stress (Shear + Torsion)	13.02 ksi.

ANGLE SUMMARY

LIMIT STATE		GOVERNING SECTION MODULUS	
Yield Moment (Major/X Axis)	44.38	S_{x5}	1.03
Yield Moment (Minor/Y Axis)	44.38	S_{y2}	1.03
LTB (Major: SL in Compression/ Geometric: Toe in tension)	44.38	S_{x5}	1.03
LTB (Major: LL in Compression/ Geometric: Toe in compression)	37.67	S_{y2}	1.03
LLB (Major/X Axis SL in Compression)	116.83	S_{x2}	2.78
LLB (Major/X Axis LL in Compression)	43.21	S_{x5}	1.03
LLB (Minor/Y Axis SL in Compression)	43.21	S_{y2}	1.03
LLB (Minor/Y Axis LL in Compression)	116.83	S_{y5}	2.78

Note: This spreadsheet **does not** perform any **deflection** checks. User should satisfy serviceability criteria outside of this spreadsheet.