
ADDENDUM NO. 3

RIDGWAY FIRE STATION LOT 26-B1 RIDGWAY, CO 81432

June 13, 2014

This Addendum is issued to inform the Bidders of Revisions and Clarifications to the Bid Documents. This Addendum forms part of the Contract Documents and modifies the original Project Manual and Bid Drawing Set dated May 9, 2014 and issued as "Ridgway Fire Station, Issue A Bid Documents". This Addendum consists of (81) 8-1/2 x 11 typed pages.

The Bid Date is unchanged by this addendum and remains **June 19, 2014 at 4:00 pm.**

You must acknowledge this addendum on your Bid Proposal.

DRAWING SHEETS

None

SPECIFICATION SECTIONS

000000	Issue Log	Updated
000000	Drawing Index	Updated
000000	Specification Index	Updated
012300	Alternates	Updated
083613	Sectional Doors	Revised
220700	Plumbing Insulation	Revised
230923.13	Operator Interface	New
283111	Digital Addressable Fire Alarm	Revised

CLARIFICATIONS

1. Please provide an Alternate Cost to include the Solar Hot Water System on the DDC controls.
2. Specification Section 072726 Fluid Applied Air Barriers, Sto Guard Air Seal may be included in the list of available or equal products.
3. Regarding the Fire Rated Overhead Coiling Door, please see Revised Specification 283111 for additional information in regards to the connection to the Fire Alarm.

CONTRACTOR QUESTIONS

LANDSCAPING QUESTIONS:

- 1.1 CLARIFICATION: IRRIGATION PERFORMANCE REQUIREMENT: Plantings and irrigation to use 50% less potable water from the calculated baseline for the site's peak watering month (July). Reductions must be achieved through plant species selection and irrigation system efficiency, as calculated by the Environmental Protection Agency (EPA) WaterSense Water Budget Tool. http://www.epa.gov/WaterSense/water_budget/ Choose xeric and low water plants, limit turf grass, and correctly zone irrigation system

- 1.2 On Sheet A0.4, Planting Schedule shows 1 1/2" Caliper and 5 Blue spruce. Which is correct as there is a difference in price?

Response: Please use the quantities shown on the Landscaping Plan rather than the Planting List. In the event of discrepancies, the Landscaping Plan shall govern.

- 1.3 Specification Section 107500 Flag Poles references a shoebase pole mount while the drawings reference concrete mount. Please clarify.

Response: Please feel free to provide pricing for either an in ground pole or embedded in concrete.

- 1.4 Specification Section 107500 Flag Poles references a 20' pole height while the Drawings indicate a 25' height. Please clarify.

Response: Please provide costs for a 20' pole.

ARCHITECTURAL QUESTIONS

- 2.1 After review of the information we have for this project I am unable to locate information regarding the percentage for payment application retention, liquidated damages (if any), and the warranty/maintenance period for this project. Can you direct me to where I might find these?

Response: The information will be contained in the Owner/Contractor contract. The specs reference the AIA 101 Agreement and A201 General Conditions. The Owners may elect to withhold a standard 5% retainage on the first 50% of the billing. We do not anticipate a liquidated damages clause at this time. Please anticipate a standard 1 year construction warranty. There may be a few extended warranties within the specs.

- 2.2 Do you know where I can find what glass goes where?

Response: The Glazing Designations for the doors are listed on the Door Schedule, Addendum #1, Sheet A6.1. The GL-1 and GL-2 designations are for exterior windows. GL-3 is intended for skylights. GL-4 and GL-5 are intended for interior applications.

- 2.3 Regarding the showers, were should the waterproof membrane installed? The walls or just the shower pans?

Response: Per Shower Floor Detail 2/A7.1, the membrane should extend up the wall in the shower stalls.

- 2.4 Specification Section 096813 Tile Carpeting, the drawings specify \$35/sy allowance, it is assumed this is for material and labor?

Response: The allowance was intended to delineate materials only.

- 2.5 Regarding Specification 083613, standard lift doors are not available with hoist.

Response: Please see revised Specification Section 083613 Sectional Doors.

- 2.6 Regarding Specification 083613, the door finish may not be available with a powder coat option.

Response: Please see revised Specification Section 083613 Sectional Doors.

STRUCTURAL QUESTIONS:

- 3.1 Please refer to details 1 and 3/SD3.2: These tubes are to receive a CJP weld. Am I correct in the assumption that the tubes will be coped at the lines where the weld symbol points to and then pieces of tube will be mitered and cope to fit along the lines shown?

Response: Yes, the detail is showing cutting and mitering with a CJP weld along the lines shown.

- 3.2 The continuous footing schedule calls out footing type CF1.3 as 1'-6" wide and the structural plan S1.0 calls out the width to be 1'-4". Please advise.

Response: The 1'-4" dimension as labeled on the plans shall govern.

MECHANICAL QUESTIONS:

- 4.1 CLARIFICATION: The Basis of Design for the Domestic Pressure Boosting Pump is a Grundfos BMQE/MQ.

- 4.2 M0.8 Boiler room not sized. The only size on the boiler room is 1-1/2", minimum size should be 3"

Response: See Sheets M-5 and M-6 for mechanical piping layout and labeled pipe sizes.

- 4.3 Snowmelt is also not sized. Please advise.

Response: See Sheets M-5 and M-6 for mechanical piping layout and labeled pipe sizes.

- 4.4 Boiler room piping not designed as per manufacturer recommendations.

Response: See Addendum #2 for revised piping on M0.8.

- 4.5 Cast iron underground piping for plumbing?

Response: Cold water mains under slab is Type K copper, DWV under slab is cast iron: See Specifications Section 221116, PART 2 – PRODUCTS and PART 3 - EXECUTION, 3.2 PIPING INSTALLATION.

- 4.6 Type "K" copper throughout for heat and plumbing piping?

Response: Yes Type K copper: For hydronic piping: See Specifications Section 232113, PART 2 – PRODUCTS and PART 3 - EXECUTION, 3.1 PIPING INSTALLATION.

- 4.7 Can you confirm the plumbing and mechanical permits/inspections are included in the Building Permit?

Response: No. A Plumbing Permit will need to be pulled and paid for separately.

- 4.8 Can you confirm the Seismic Design Criteria on S0.0?

Response: The Seismic Design Criteria is necessary for the Type IV Occupancy Classification associated with Essential Facilities.

- 4.9 Please confirm insulation thickness for Domestic water supplies HW, HWRC, CW.

Response: See Updated Specifications Section 220700, PART 3 - EXECUTION, 3.17A.

- 4.10 Please confirm RD & ORD sizing.

Response: 4" diameter.

- 4.11 Confirm who provides TD-1 it is scheduled on the Plumbing Fixtures and then noted on P0.3 it is required of the GC. Please clarify

Response: TD-1 by GC with drain piping by Plumbing Contractor

- 4.12 Is there a detail for The PBS-1?

Response: See Sheet P0.2 in Addendum #2.

- 4.13 Is BFP-1 the Irrigation backflow preventer to be supplied by the Landscape Contractor ?

Response: BFP-1 is used for CW to the building and the Landscape, so quantity of two (2) BFP-1. One supplied by plumbing contractor and one supplied by landscaping contractor. BFP-2 is a 2 inch backflow preventer on its own separate supply line, separate meter to fill fireman's fill (FF-1) for filling fire trucks.

- 4.14 Spec Section 220700 shows "Indoor Piping Insulation Schedule".

Response: Please see updated specification 220700, Plumbing Insulation.

- 4.15 Should I exclude insulation for Hot and Cold Water plumbing piping or Roof Drain piping?

Response: No, see above note for updated specification 220700, Plumbing Insulation. Please keep in mind that this is LEED project.

- 4.16 PEX is not listed in the water piping specification schedule (SS 221113), so water piping cost will be (unnecessarily) increased to provide L Copper.

Response: PEX can be used.

- 4.17 I have been through the plumbing spec several times and have been unable to find waste and roof drain piping requirements.

Response: PVC or ABS can be used.

- 4.18 Note no Specification Section for DWV/SS is provided. (None provided for Fixtures or Equipment either)

Response: ABS and PVC can be used.

- 4.19 Drawing detail notes identify DWV as Cast Iron, including underground.

Response: ABS and PVC can be used.

- 4.20 Roof drain piping appears to be drawn as 4" dia., but is not specifically annotated as such.

Response: 4" diameter.

- 4.21 I don't believe the 'Lead Caulk' shown on P0.3 DSN detail is legal.

Response: Please disregard the note. No lead caulk.

- 4.22 I would note also that no Fixture Connection Schedule was provided.

Response: A Fixture Connection Schedule will be provided in the final Construction Drawings.

- 4.23 Will the solar system be stand alone or on the DDC?

Response: It should be standalone although please provide a line item cost to include it on DDC.

- 4.24 There is a conflict on the unit heaters that states DDC control, yet I have on the plans to use programmable thermostats.

Response: The Unit Heaters should be controlled by programmable thermostats.

ELECTRICAL QUESTIONS:

- 5.1 Is the wiring for the EM lights to be considered an actual emergency system? If so then all the wiring for these lights would need to be in their own separate raceway?

Response: The emergency lighting is supplied by an inverter based system and should be run in separate conduits up to the emergency power control module provided at each switch leg. Please see the power riser diagram.

FIRE ALARM QUESTIONS:

- 6.1 CLARIFICATION: The fire station alert system as shown on the Low Voltage Plan, E-1.05 shall be included in the bid. The basis of design for this system is ComTech 10 LTD or approved equal. Contact information for Comtech is:

ComTech Communications
Office: (916) 568-7800 FAX: (916) 568-3555
120 Main Avenue Sacramento, CA 95838
POC: Dave Johnson

- 6.2 On sheet E-1.05 there is a comment in the note describing the fire alarm alerting system. It says that 120 volt power is required and that it is not installed by "Comtech". Is Comtech the suppliers of this alert system? If so, are they going to be hired directly by the owner?

Response: Yes, the FSAS system is based on Comtech. No the FSAS alert system is not supplied by the Owner it is to be part of the bid. We will clarify this in the addendum #3 Friday.

- 6.3 Also, is the fire alarm system part of this alert system? It appears that the two are integral with each other on the drawings. Can you please clarify if we are to supply and install this entire system using our own vendors, or if there is a particular system vendor that the owner is hiring directly to install this system? Are we to only supply j-boxes and conduit stubs to accessible ceilings for the system or does the entire fire alarm/alert system need to be installed in EMT conduit?

Response: The Fire alarm system is not part of the alert system although the two systems talk to each other. The contractor (bidder) will install both systems per the spec for low voltage systems and fire alarm systems

- 6.4 No automatic detection is shown in the dorm rooms or anywhere else is it required?

Response: Please reference revised Specification 283111, Digital Addressable Fire Alarm System.

- 6.5 No CO detection is shown in kitchen is it required (one line shows smoke detectors but not on print.)

Response: Please reference revised Specification 283111, Digital Addressable Fire Alarm System.

- 6.6 Speakers on print are A/V speakers per A/V one line with volume controls are they part of the "FSAS" system and don't they need to be UL listed for it?

Response: The speakers indicated on the plans are for the FSAS System. The AV speakers will be provided by the Owner.

- 6.7 In the Dorm rooms plans show a speaker strobe with volume controls is that legal per code?

Response: Yes, the speaker strobe is a component of the FSAS System.

- 6.8 In the Apparatus Bay they show 30W 360 deg. Speakers and strobes in between them are they to UL listed for Life Safety paging or are they part of the A/V system.

Response: The speakers indicated on the plans are for the FSAS System. The AV speakers will be provided by the Owner.

END OF ADDENDUM

Issue Log

** Items in Italics have not been issued.*

ISSUE NAME	DESCRIPTION	ISSUE SET	ISSUE DATE
Bidding Set	Drawings and Specifications	A	5/9/14

REVISION DOCUMENTS	DESCRIPTION	ISSUE SET	ISSUE DATE
Addendum #1		Add 1	6/2/14
Addendum #2		Add 2	6/10/14
Addendum #3		Add 3	6/13/14

END OF ISSUE LOG

Drawing Index

** Items in Italics have not been issued.*

***Items in Bold have been revised.**

NUMBER	DRAWING NAME	ISSUE SET	ISSUE DATE
GENERAL			
A0.1	COVER SHEET	A	5/9/14
A0.2	LIFE SAFETY PLAN	A	5/9/14
CIVIL			
C.1	EXISTING CONDITIONS	Add 1	6/2/14
C.2	SITE LAYOUT & UTILITIES PLAN	Add 1	6/2/14
C.3	GRADING & DRAINAGE PLAN	Add 1	6/2/14
C.4	DETAILS	Add 1	6/2/14
ARCHITECTURAL			
A0.3	LANDSCAPING PLAN	A	5/9/14
A0.4	SITE DETAILS	A	5/9/14
A1.1	FLOOR PLAN	A	5/9/14
A1.2	MEZZANINE PLAN	A	5/9/14
A1.3	ROOF PLAN	A	5/9/14
A2.1	ELEVATIONS	A	5/9/14
A2.2	ELEVATIONS	A	5/9/14
A3.1	BUILDING SECTIONS	A	5/9/14
A3.2	BUILDING SECTIONS	A	5/9/14
A3.3	BUILDING SECTIONS	A	5/9/14
A4.1	MAIN LEVEL CEILING PLAN	Add 2	6/10/14
A4.2	MEZZANINE CEILING PLAN	A	5/9/14
A5.1	ENLARGED PLAN	A	5/9/14
A5.2	ASSEMBLY TYPES	A	5/9/14
A5.3	WALL SECTIONS	A	5/9/14
A5.4	DETAILS	A	5/9/14
A5.5	DETAILS	A	5/9/14
A5.6	DETAILS	A	5/9/14
A6.1	DOOR SCHEDULE	Add 1	6/2/14
A6.2	WINDOW SCHEDULE	A	5/9/14
A6.3	DOOR & WINDOW DETAILS	A	5/9/14

A7.1	FINISH SCHEDULE & DETAILS	A	5/9/14
A7.2	INTERIOR ELEVATIONS	A	5/9/14
A7.3	INTERIOR ELEVATIONS	A	5/9/14
A8.1	INTERIOR VIEWS	A	5/9/14
A8.2	INTERIOR VIEWS	A	5/9/14
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S0.0	GENERAL NOTES & LEGENDS	A	5/9/14
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S1.0	FOUNDATION PLAN	A	5/9/14
S2.0	MEZZANINE FLOOR – FLAT ROOF FRAMING PLAN	A	5/9/14
S3.0	ROOF FRAMING PLAN	A	5/9/14
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SD1.1	CONCRETE DETAILS	A	5/9/14
SD2.0	MASONRY DETAILS	A	5/9/14
SD3.0	STEEL DETAILS	A	5/9/14
SD3.1	STEEL DETAILS	A	5/9/14
SD3.2	STEEL DETAILS	A	5/9/14
SD4.0	WOOD DETAILS	A	5/9/14
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SD4.2	WOOD DETAILS	A	5/9/14
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M0.3	SCHEDULES	A	5/9/14
M0.4	SCHEDULES CONTINUED	A	5/9/14
M0.5	CONTROL SEQUENCE	A	5/9/14
M0.6	AIRSIDE DETAILS	A	5/9/14
M0.7	AIRSIDE DETAILS	A	5/9/14
M0.8	BOILER PLANT DETAILS	Add 2	6/10/14
M1	MECHANICAL PLAN – LEVEL 1	Add 2	6/10/14
M2	MECHANICAL PLAN – LEVEL 2	A	5/9/14
M3	ROOF PLAN	Add 2	6/10/14
M4	MECHANICAL – 3D	A	5/9/14

M5	MECH PIPING PLAN – LEVEL 1	A	5/9/14
M6	MECH PIPING PLAN – LEVEL 2	A	5/9/14
PLUMBING			
P0.1	PLUMBING NOTES AND SCHEDULES	Add 2	6/10/14
P0.2	PLUMBING DETAILS	Add 2	6/10/14
P0.3	PLUMBING DETAILS	A	5/9/14
P0.4	PLUMBING DETAILS	A	5/9/14
P1	PLUMBING PLAN – LEVEL 1	A	5/9/14
P2	PLUMBING – 3D	A	5/9/14
ELECTRICAL AND LIGHTING			
E0.01	ELECTRICAL TITLE PAGE	A	5/9/14
E1.01	POWER PLAN – MAIN LEVEL	A	5/9/14
E1.02	POWER PLAN – UPPER LEVEL	A	5/9/14
E1.03	LIGHTING PLAN - MAIN LEVEL	A	5/9/14
E1.04	LIGHTING PLAN - UPPER LEVEL	A	5/9/14
E1.05	LOW VOLTAGE PLAN - MAIN LEVEL	A	5/9/14
E5.01	POWER DETAILS AND SCHEDULES	A	5/9/14
E5.02	LIGHTING DETAILS AND SCHEDULES	A	5/9/14
E5.03	LOW VOLTAGE DETAILS AND SCHEDULES	A	5/9/14

END OF DRAWING INDEX

Specification Index

** Items in Italics have not been issued.*

***Items in Bold have been revised.**

DIV NO.	DIVISION TITLE	ISSUE SET	ISSUE DATE
DIVISION 00 – PROCUREMENT AND CONTRACT REQUIREMENTS			
00	Project Title Page	A	5/9/14
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02	Advertisement for Bids	A	5/9/14
03	Bid Instructions	A	5/9/14
04	Bid Form	Add 2	6/10/14
05	Issue Log	Add 3	6/13/14
06	Drawing Index	Add 3	6/13/14
07	Specification Index	Add 3	6/13/14
08	Geotechnical Data Summary	A	5/9/14
09	LEED 2009 NC Certification Checklist (Preliminary)	A	5/9/14
DIVISION 01 – GENERAL REQUIREMENTS			
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012100	Allowances	A	5/9/14
012200	Unit Prices	A	5/9/14
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012500	Substitution Procedures	A	5/9/14
012600	Contract Modification Procedures	A	5/9/14
012900	Payment Procedures	A	5/9/14
013100	Project Management and Coordination	Add 1	6/2/14
013200	Construction Progress Documentation	A	5/9/14
013300	Submittal Procedures	A	5/9/14
014000	Quality Requirements	A	5/9/14
014200	References	A	5/9/14
015000	Temporary Facilities and Controls	A	5/9/14
016000	Product Requirements	A	5/9/14
017300	Execution	A	5/9/14
017419	Construction Waste Management	Add 1	6/2/14
017700	Closeout Procedures	A	5/9/14

017823	Operation and Maintenance Data	A	5/9/14
017900	Demonstration and Training	A	5/9/14
018113	Sustainable Design Requirements	Add 1	6/2/14
019113	General Commissioning Requirements	Add 1	6/2/14
DIVISION 03 - CONCRETE			
033000	Cast-In-Place Concrete	Add 1	6/2/14
033543	Polished Concrete Finishing	A	5/9/14
DIVISION 04 – MASONRY			
042200	Concrete Unit Masonry	A	5/9/14
DIVISION 05 – METALS			
051200	Structural Steel Framing	A	5/9/14
052100	Steel Joist Framing	A	5/9/14
053100	Steel Decking	A	5/9/14
055000	Metal Fabrications	A	5/9/14
055113	Metal Pan Stairs	A	5/9/14
055213	Pipe and Tube Railings	A	5/9/14
DIVISION 06 – WOOD, PLASTICS, & COMPOSITES			
061000	Rough Carpentry	Add 1	6/2/14
061600	Sheathing	A	5/9/14
061753	Shop-Fabricated Wood Trusses	A	5/9/14
061800	Glued-Laminated Construction	A	5/9/14
DIVISION 07 – THERMAL & MOISTURE PROTECTION			
071113	Bituminous Dampproofing	A	5/9/14
072100	Thermal Insulation	A	5/9/14
072726	Fluid Applied Air Barriers	Add 1	6/2/14
074113	Standing Seam Metal Roof Panels	A	5/9/14
074619	Metal Wall Panels	Add 1	6/2/14
075423	TPO Roofing	A	5/9/14
076200	Sheet Metal Flashing and Trim	A	5/9/14
077200	Roof Accessories	A	5/9/14

079200	Joint Sealants	A	5/9/14
078413	Penetration Firestopping	Add 1	6/2/14
DIVISION 08 – OPENINGS			
081213	Hollow Metal Door Frames	Add 1	6/2/14
081416	Flush Wood Doors	Add 1	6/2/14
081436	Stile and Rail Wood Doors	Add 1	6/2/14
083113	Access Doors and Frames	A	5/9/14
083213	Sliding Aluminum Framed Glass Doors	Add 1	6/2/14
083313	Coiling Counter Doors	Add 1	6/2/14
083613	Sectional Doors	Add 3	6/13/14
085113	Aluminum Windows	Add 1	6/2/14
086300	Metal-Framed Skylights	Add 1	6/2/14
087100	Door Hardware	Add 2	6/10/14
088000	Glazing	Add 1	6/2/14
089000	Louvers and Vents	Add 1	6/2/14
DIVISION 09 – FINISHES			
092116	Gypsum Board Shaft Wall Assemblies	Add 1	6/2/14
092900	Gypsum Board	Add 1	6/2/14
093000	Ceramic Tiling	Add 1	6/2/14
095123	Acoustic Tile Ceilings	A	5/9/14
096513	Resilient Base and Accessories	A	5/9/14
096813	Tile Carpeting	A	5/9/14
099000	Paints and Coatings	Add 1	6/2/14
099300	Staining and Transparent Finishing	A	5/9/14
099600	High Performance Coatings		
DIVISION 10 – SPECIALTIES			
101100	Visual Display Units	A	5/9/14
101200	Display Cases	A	5/9/14
101400	Signage	A	5/9/14
102113	Toilet Compartments	A	5/9/14
102800	Toilet Accessories	A	5/9/14
104400	Interior Signs	A	5/9/14

104413	Fire Protection Cabinets	A	5/9/14
104416	Fire Extinguishers	A	5/9/14
105113	Metal Lockers	Add 1	6/2/14
107500	Ground-Set Flag Poles	A	5/9/14
DIVISION 11 – EQUIPMENT			
115213	Projection Screens	A	5/9/14
DIVISION 12 – FURNISHINGS			
122413	Roller Window Shades	Add 1	6/2/14
123530	Residential Casework	Add 1	6/2/14
124816	Entrance Floor Grills	A	5/9/14
DIVISION 22 - PLUMBING			
220500	Common Work Results	A	5/9/14
220513	Common Motor Requirements	A	5/9/14
220516	Expansion Fittings and Loops	A	5/9/14
220519	Meters and Gauges	A	5/9/14
220523	General Duty Valves	A	5/9/14
220529	Hangers and Supports	A	5/9/14
220548	Vibration and Seismic	A	5/9/14
220553	Identification	A	5/9/14
220700	Plumbing Insulation	Add 3	6/13/14
221113	Facility Water Distribution Piping	A	5/9/14
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230513	Common Motor Requirements	A	5/9/14
230516	Expansion Fittings and Loops	A	5/9/14
230519	Meters and Gauges	A	5/9/14
230523	General Duty Valves	A	5/9/14
230529	Hangers and Supports	A	5/9/14
230548	Vibration and Seismic	A	5/9/14
230553	Identification	A	5/9/14
230593	Testing and Balancing	A	5/9/14
230700	HVAC Insulation	A	5/9/14

230800	HVAC Commissioning	A	5/9/14
230900	Instruments and Controls	A	5/9/14
230923.13	Operator Interface	Add 3	6/13/14
230993	Sequence of Operations	A	5/9/14
231123	Natural Gas Piping	A	5/9/14
23500	HVAC Water Treatment	A	5/9/14
23313	Metal Ducts	A	5/9/14
233116	Non-Metal Ducts	A	5/9/14
233119	HVAC Casings	A	5/9/14
233300	Air Duct Access	A	5/9/14
233416	Centrifugal HVAC Fans	A	5/9/14
233423	Power Ventilators	A	5/9/14
233600	Air Terminal Units	A	5/9/14
233713	Diffusers, Grilles, and Registers	A	5/9/14
234100	Particulate Air Filtration	A	5/9/14
235100	Breeches, Chimneys and Stacks	A	5/9/14
235113	Draft Control Devices	A	5/9/14
235216	Condensing Boilers	A	5/9/14
235700	Heat Exchangers	A	5/9/14
237433	Heating and Cooling Make-Up Air	A	5/9/14
238219	Fan Coil Units	A	5/9/14
238239	Unit Heaters	A	5/9/14
238316	Radiant Heating Hydronic Piping	A	5/9/14
DIVISION 26 - ELECTRICAL			
260500	Common Work Results	A	5/9/14
260519	Low Voltage	A	5/9/14
260523	Control Voltage	A	5/9/14
260526	Grounding	A	5/9/14
260533	Raceways and Boxes	A	5/9/14
260553	Identification	A	5/9/14
260923	Lighting Control	A	5/9/14
262416	Panel Boards	A	5/9/14
262726	Wiring Devices	A	5/9/14
262813	Fuses	A	5/9/14

262816	Enclosed Switches	A	5/9/14
264313	TVs	A	5/9/14
265100	Interior Lighting	A	5/9/14
283111	Digital, Addressable Fire Alarm System	Add 3	6/13/14
DIVISION 32 – EXTERIOR IMPROVEMENTS			
328400	Planting Irrigation	Add 1	6/2/14
329200	Turf and Grasses	A	5/9/14
329300	Plants	A	5/9/14

END OF SPECIFICATION INDEX

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

1.2 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into 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 indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. **Alternate No. 1 – Deductive Amount for Kitchen Base and Upper Cabinets.**
- B. **Alternate No. 2 – Additive Amount to include the Solar Hot Water Preheat System on the DDC. (Addendum #3)**

END OF SECTION 012300

SECTION 083613 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes electrically operated sectional doors.

1.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
- B. Delegated Design: Design sectional doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Exterior sectional doors shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Wind Loads: As indicated on Structural Drawings.
- D. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283 or DASMA 105.
 - 1. **Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. at 15 and 25 mph.**

1.3 SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Delegated-Design Submittal: For sectional doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Seismic Qualification Certificates: For sectional doors, accessories, and components, from manufacturer.
- F. Maintenance data.
- G. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer. Provide secondary components from a source acceptable to the manufacturer of the primary components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 STEEL DOOR SECTIONS

- A. Exterior Section Faces and Frames: Fabricate from manufacturer's standard zinc-coated (galvanized), cold-rolled, steel sheet.
 - 1. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weathertight seal, with a reinforcing flange return.
 - 2. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.
- B. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place.
- C. Provide reinforcement for hardware attachments.
- D. Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:

2.2 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Manufacturer's heavy duty, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances shown on Drawings. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced 2 inches apart for door-drop safety device. Slope tracks at proper angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.
- B. Track Reinforcement and Supports: Galvanized-steel track reinforcement and support members. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.
- C. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.
- D. Windows: Manufacturer's standard window units of type and size indicated and in arrangement shown. Provide removable stops of same material as door-section frames.

2.3 HARDWARE

- A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
- B. Hinges: Heavy-duty, galvanized-steel hinges at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails.
- C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Provide 3-inch- diameter roller tires for 3-inch- wide track and 2-inch- diameter roller tires for 2-inch- wide track.

2.4 COUNTERBALANCE MECHANISM

- A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.
- B. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.
- C. Cables: Galvanized-steel lifting cables.
- D. Cable Safety Device: Include, on each side-edge of door, a device designed to automatically stop door if either lifting cable breaks.
- E. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
- F. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

2.5 MANUAL DOOR OPERATORS

- A. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.6 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door-Operator Type: Unit of type indicated, consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
- D. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements for Equipment" unless otherwise indicated.
 - 1. Electrical Characteristics:
 - a. Phase: Single phase.
 - b. Volts: 115 V.
 - c. Hertz: 60.
 - 2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
 - 3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
- E. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
 - 1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
- ~~F. Red/Green Traffic Light: Equip motorized door with a flashing light kit to signal the operator that the door is in the full open position. Wall mount the traffic light per the manufacturer's instructions (Not Required per Addendum #3)~~

- G. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
 - 1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 - H. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
 - I. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
 - J. Radio-Control System: Consisting of three-channel universal coaxial receiver to open, close, and stop door; two per operator.
- 2.7 DOOR ASSEMBLY – (DOORS 001, 002, 003, 004 and 005)
- A. Steel Sectional Door: Sectional door formed with hinged sections.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Overhead Door Corporation.
 - b. Raynor Manufacturing.
 - c. Windsor Republic Doors.
 - d. Substitutions: Section 016000
 - B. Operation Cycles: Not less than 50,000.
 - C. Installed R-Value: R-7 Minimum
 - D. Steel Sections: **~~20~~ 24 gauge Zinc-coated (galvanized) steel sheet, formed into sections 2 inches thick with extruded polystyrene core.**
 - 1. Exterior-Face Surface: Flat **or Ribbed.**
 - 2. Interior Facing Material: Zinc-coated (galvanized) steel sheet.
 - E. Track Configurations:
 - 1. Doors 001, 002, 003, 4004 – Standard Lift Track
 - 2. Door 005 – Low Head Room Track, less than 8" clearance
 - F. Interior Facing Material: Zinc-coated (galvanized) steel sheet
 - G. Weatherseals: Fitted to bottom and top and around entire perimeter of door.
 - H. Windows: Approximately 24 inches tall spanning an entire panel row, with square corners, with a sill height of approximately 4 feet; installed with insulated glazing of tempered clear float glass.
 - I. Manual Door Operator: Chain-hoist operator.

J. Electric Door Operator:

1. ~~Usage Classification: Heavy use.~~
2. ~~Operator Type: Trolley.~~
3. ~~Motor Exposure: Interior, clean, and dry.~~
4. ~~Emergency Manual Operation: Chain type.~~
5. ~~Obstruction Detection Device: Automatic photoelectric sensor.~~
6. ~~Remote Control Station: Interior.~~
7. ~~Other Equipment: Radio control system.~~

1. **Furnish electric door operator assembly of size and capacity recommended and provided by door manufacturer for heavy duty fire station type applications.**

K. Door Finish:

1. Baked-Enamel or Powder-Coated Finish, **or a finish that meets the Special Finish Warranty duration listed in Section 1.5:**
 - a. Basis of Design: Drylac Powder Coatings, RAL 3004, "Dark Red"
 - b. As selected by Architect from Manufacturer's full, custom selection
2. Factory Prime Finish: Manufacturer's standard color.
3. Finish of Interior Facing Material: Powder-Coated, Manufacturer's "White".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Tracks: Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment. Repair galvanized coating on tracks according to ASTM A 780.
- C. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Adjust doors and seals to provide weathertight fit around entire perimeter.

3.2 DEMONSTRATION

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

END OF SECTION 083613

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyolefin.
 - e. Polystyrene.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied fabric-reinforcing mesh.
8. Field-applied jackets.
9. Tapes.
10. Securements.
11. Corner angles.

B. Related Sections include the following:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 23 Section "HVAC Insulation."

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
 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. Johns Manville; HTB 23 Spin-Glas.
 - b. Owens Corning; High Temperature Flexible Batt Insulations.
- I. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
 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. Fibrex Insulations Inc.; FBX.
 - b. Johns Manville; 1000 Series Spin-Glas.
 - c. Owens Corning; High Temperature Industrial Board Insulations.
 - d. Rock Wool Manufacturing Company; Delta Board.
 - e. Roxul Inc.; Roxul RW.
 - f. Thermafiber; Thermafiber Industrial Felt.
- J. Mineral-Fiber, Preformed Pipe Insulation:
 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. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 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. CertainTeed Corp.; CrimpWrap.

- b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.
- L. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - a. Armacell LLC; Tubolit.
 - b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
 - c. RBX Corporation; Therma-cell.
- M. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 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. Dow Chemical Company (The); Styrofoam.
 - b. Knauf Insulation; Knauf Polystyrene.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
 - 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. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 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. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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. Aeroflex USA Inc.; Aero seal.
- b. Armacell LCC; 520 Adhesive.
- c. Foster Products Corporation, H. B. Fuller Company; 85-75.
- d. RBX Corporation; Rubatex Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following

- a. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.

E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.

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. Childers Products, Division of ITW; CP-96.
- b. Foster Products Corporation, H. B. Fuller Company; 97-13.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

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. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

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. Dow Chemical Company (The); 739, Dow Silicone.
- b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
- c. P.I.C. Plastics, Inc.; Welding Adhesive.
- d. Red Devil, Inc.; Celulon Ultra Clear.
- e. Speedline Corporation; Speedline Vinyl Adhesive.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
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. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
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. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 200 deg F.
 4. Solids Content: 63 percent by volume and 73 percent by weight.
 5. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
 2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following

- a. Childers Products, Division of ITW; CP-70.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 4. Permanently flexible, elastomeric sealant.
 5. Service Temperature Range: Minus 100 to plus 300 deg F.
 6. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
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. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
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. Childers Products, Division of ITW; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

- 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) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 5. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - 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) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - 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) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch in a Leno weave, for equipment and pipe.
 - 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. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: Color-code jackets based on system. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 4. Factory-fabricated tank heads and tank side panels.
- C. Aluminum Jacket: Comply with ASTM B 209 Alloy 3003, 3005, 3105 or 5005, Temper H-14.
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. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Factory cut and rolled to size.
 3. Finish and thickness are indicated in field-applied jacket schedules.
 4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 6. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
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. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

- d. Venture Tape; 3520 CW.
 - 2. Width: 2 inches.
 - 3. Thickness: 3.7 mils.
 - 4. Adhesion: 100 ounces force/inch in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
- 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. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - 2. Width: 3 inches.
 - 3. Film Thickness: 6 mils.
 - 4. Adhesive Thickness: 1.5 mils.
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
- 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. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
- B. Insulation Pins and Hangers:
- 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - 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) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, galvanized steel.
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. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.
 - e.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch , aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches.
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
 - 1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 - 2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 - 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 - 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 - 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 FINISHES

- A. Equipment and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 - 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

- A. Round, Exposed Breeching and Connector Insulation: High-temperature mineral-fiber board, 3 inches thick and 3-lb/cu. ft. nominal density.
- B. Round, Concealed Breeching and Connector Insulation: High-temperature mineral-fiber board, 3 inches thick and 3-lb/cu. ft. nominal density.

3.15 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Heat-Exchanger (Water-to-Water for Domestic Water Heating Service) Insulation: Mineral-Fiber Pipe and Tank: 2 inches thick.
- D. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber Pipe and Tank: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- E. Domestic Hot-Water Storage Tank Insulation: Mineral-Fiber Pipe and Tank: 4 inches thick.
- F. Piping System Filter-Housing Insulation: Mineral-Fiber Pipe and Tank: 2 inches thick.

3.16 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.17 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- B. Domestic Chilled Water (Potable): Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- C. Stormwater and Overflow: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- F. Sanitary Waste Piping Where Heat Tracing Is Installed: Insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

3.18 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping: Insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 2 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
4. Polyolefin: 2 inches thick.
5. Polystyrene: 2 inches thick.

B. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:

1. Cellular Glass: 2 inches > thick.
2. Flexible Elastomeric: 2 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
4. Polyolefin: 2 inches thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed: Insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.19 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.
- B. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.

3.20 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
 1. None.
 2. PVC, Color-Coded by System: 30 mils thick.
 3. Aluminum, Corrugated 0.040 inch thick.
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 1. None.
 2. PVC, Color-Coded by System: 30 mils thick.
 3. Aluminum, Corrugated 0.040 inch thick.
- E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches :
 1. None.
 2. Painted Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations: 0.032 inch thick.
- F. Piping, Concealed:

1. None.
2. PVC, Color-Coded by System: 30 mils thick.
3. Aluminum, Corrugated: 0.040 inch thick.

G. Piping, Exposed:

1. None.
2. PVC, Color-Coded by System: 30 mils thick.
3. Aluminum, Corrugated: 0.040 inch thick.

3.21 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC, Color-Coded by System: 30 mils thick.
3. Aluminum, Corrugated: 0.040 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Painted Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations: 0.032 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Painted Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations: 0.032 inch thick.

F. Piping, Concealed:

1. None.
2. PVC, Color-Coded by System: 30 mils thick.
3. Aluminum, Corrugated: 0.040 inch thick.

G. Piping, Exposed:

1. PVC: 40 mils thick.
2. Painted Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations: 0.032 inch thick.

3.22 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220700

SECTION 230923.13 – OPERATOR INTERFACE

Operator Interface

- A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a standalone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.
- B. Operator Interface. Furnish one Web server interface as shown on the system drawings. Operators shall be able to access all necessary operational information in the DDC system via client computer utilizing web browser.
1. Web server shall connect via the LAN and be able to simultaneously serve up controller information to multiple operators connected via LAN with web browsers. Each client web browser connected to server shall be able to access all system information.
 2. With the use of a remote SMTP email server the operators interface web server shall be able to notify personnel of an alarm or record information about an alarm in the DDC system.
 3. Secondary interface, in addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone and tablet devices. As a minimum, the following capabilities shall be provided through this interface:
 - a. Secondary interface with screen resolution 1024x768 and above shall be able to provide a full graphical environment as the primary interface.
 - b. Secondary interface with screen resolution lower than 1024x768 may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:
 - i. An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.
 - ii. The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.
 - iii. A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.
 - iv. Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system, and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.

- C. Web Server Hardware. Furnish one web server with Ethernet port for LAN or direct operator client computer access. The web server shall be capable of communicating to the peer to peer DDC controller network. Any required installation or commissioning software shall be pre-installed on the web server. Installation or commissioning of the web server shall be done through a client computer with a standard web browser.
- D. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- E. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
 - 1. Log In and Log Out. System shall require user name and password to log in to operator interface.
 - 2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
 - 3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.
 - 4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
 - 5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.
 - 6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
 - 7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
 - 8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
 - 9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.
- B. System Software.
 - 1. Operating System and required software. Web server operator interface shall be a self contained web server without the need for any type of maintenance.
 - 2. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

- a. **Functionality.** Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. **Animation.** Graphics shall be able to animate by displaying different image files for changed object status.
 - c. **Alarm Indication.** Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. **Format.** Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
- C. **System Tools.** System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard Windows compatible PCs with no limit on the number of copies that can be installed under the system license.
 1. **Automatic System Database Configuration.** Each web server shall store internally store a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. **Controller Memory Download.** Operators shall be able to download memory from the system database to each controller.
 3. **System Configuration.** Operators shall be able to configure the system.
 4. **Online Help.** Context-sensitive online help for each tool shall assist operators in operating and editing the system.
 5. **Security.** System shall require a user name and password to view, edit, add, or delete data.
 - a. **Operator Access.** Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
 - b. **Automatic Log Out.** Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
 - c. **Encrypted Security Data.** Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
 6. **System Diagnostics.** System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
 7. **Alarm Processing.** System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 8. **Alarm Messages.** Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
 10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server from each workstation or web browser interface.
 11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.
 12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics.
 13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
 14. Standard Reports. Furnish the following standard system reports:
 - a. Reports shall be filtered based upon the selected equipment
 - b. Alarm Reports
 - i. Alarm Summary - Current alarms
 - ii. Alarm Sources – List of equipment and associated alarm conditions
 - iii. Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up
 - c. Schedule Reports
 - i. Effective Schedules – Displays effective schedules for each equipment
 - ii. Schedule Instances – Displays all schedules entered
 - d. Security Reports – Maintains audit of all actions taken through user interface
 - e. Commissioning Reports – Provide equipment checkout status and notes
 - f. Equipment Reports – Provide reports showing trended points and available network points
 15. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
 16. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
 17. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
- D. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect

configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

E. Web services data exchange

System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the DDC system.

1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

F. Open Protocol Communications

DDC system shall allow communication to ancillary systems or controllers, such as lighting system or VFD controllers that utilize BACnet, Modbus, or LonWorks communication protocols. The quantity of data points available per protocol shall be based upon system memory and capacity and will not require the purchase of additional licenses or fees.

1. BACnet communication
 - a. DDC System shall support BACnet/IP addressing as specified in ASHRAE/ANSI 135, BACnet Annex J using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol.
 - b. DDC System shall support BACnet MS/TP communications using EIA-485 twisted pair topology running at 9600, 19200, 38400, and 76800 baud.
2. Modbus communication
 - a. DDC System shall support Modbus RTU/ASCII communications over EIA-485/EIA-232 type network at 9600, 19200, 38400, and 76800 baud.
 - b. DDC System shall support Modbus TCP/IP communications over ISO 8802-3 (Ethernet) Data Link/Physical layer protocol.
3. LonWorks communication
 - a. DDC system shall support LonWorks communication utilizing ANSI/EIA-709.1 communications over FT-10A network.
 - b. Communication between devices shall be via Standard Network Variable Types (SNVTs)

BMS Client PC

1. Operator Client Interface

Each standard browser connected to the server shall be able to access all system information.

2. Hardware

Each client computer shall consist of the following:

Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. Provide Dual core processor, 1.5 GB RAM, 10Mbps or higher LAN communications, serial, parallel, cables as required

for proper DDC system operation. The client PC shall support a minimum screen resolution of 1024 x 768 32-bit color.

3. Browser Software

Client computer shall have an industry-standard professional-grade operating system. Operating system shall support Google™ Chrome™, Internet Explorer, Mozilla Firefox, and Safari web browsers with Java and ActiveX plugins enabled.

4. Communication

Each client shall be able to communicate to the server over a Local Area Network (LAN) or Wide Area Network (WAN) using industry standard Internet Protocols.

BMS Server PC

1. Operator Interface: Server

Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.

2. Hardware

Each workstation or web server computer shall consist of the following:

Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:

The hard disk shall have sufficient memory to store:

- a. All required operator workstation software.
- b. A DDC database at least twice the size of the delivered system database.
- c. One year of trend data based on the points specified to be trended at their specified trend intervals.

Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.

Minimum hardware configuration shall include the following:

- a. Dual or Quad Core Processor
- b. 6 GB RAM
- c. 500 GB hard disk providing data at 3.0 Gb/sec
- d. 16x DVD-RW drive

3. Operating Software

Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software. Typically acceptable systems include Microsoft Windows7, Microsoft Vista, Microsoft Windows XP Pro, Windows Server 2003 or 2008.

4. Communication

Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

5. Portable Operator's Terminal

Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

Field Installed Controller (FIC)

General Purpose Controllers

Advanced Application Controllers (AAC) shall be a solid state micro-controller with configurable control module with pre-tested and factory configured software specifically designed for regulating building equipment using closed-loop Direct Digital Control and facility management routines. Controllers shall be capable operating in a stand-alone or networked manner, and shall be located where shown on the plans. The controller shall be powered from standard, off-the-shelf, Class II, 24-volt transformers. The controller shall be easily mounted in a standard NEMA 1 type enclosure without special rails or mounting hardware and as local and national code dictates. The controller shall be capable of operating in either a stand-alone mode or as part of a network with an EMS operator's station and other system elements including Product Integrated Controllers (PIC's)

BACnet. Advanced Application Controllers (AACs). AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing. AAC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.

Custom Programming

The controller shall contain a graphical controller based programming language for creating complex control strategies for specific unique applications. Custom programs shall be retained in controller memory and shall not require a host CPU to operate. All custom programming point data shall be transferable from one controller to another (if networked) directly without an on-line CPU or host computer.

Communication.

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Data Sharing. Each AAC shall share data as required with each networked.

Environment. Controller hardware shall be suitable for anticipated ambient conditions.

3. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
4. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

Memory.

5. The Controller shall have a Non-Volatile Memory providing indefinite storage of application and configuration data.
6. Controller memory shall support operating system, database, and programming requirements.

Controller Time.

7. Controller shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions.

Stand alone capability. The controller shall be capable of providing all control functions of the HVAC system without the use of a computer.

8. It shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.

Networked capability. The controller shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and EMS software program.

9. When networked, occupancy may be established by user interface or occupancy signal from other controller located in network.

Scheduling. AAC shall provide the following schedule options as a minimum:

10. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
11. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
12. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

Serviceability.

13. Controller shall have diagnostic LEDs for power, communication, and processor.
14. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.

Immunity to Power and Noise. AAC shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

Input and output devices shall be wired to "quick-connect plug type" terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.

Alarm Processing. The controller shall contain a routine to process alarms. Alarm processing logic shall also monitor return to normal conditions as part of the alarm scan. The operator will have the ability to modify the alarm/alert priority level.

PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.

On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

Inputs. Shall support the following input types as a minimum

- a. Dry or pulsed dry contacts
- b. 0-5 VDC
- c. 0-10 VDC
- d. 4-20 mA
- e. 10K thermistors
- f. 1000-ohm Nickel RTD

Outputs. Shall support the following input types as a minimum

- g. Discrete types
 - h. 0–10 VDC analog type
 - i. 4–20 mA analog type
15. Real-Time Clock. Shall feature and maintain a 365-day hardware clock/calendar with holiday functions.
16. Library of direct digital control routines. The following types of factory tested direct digital control routines shall be provided as a minimum:
- a. Indoor/Outdoor Lighting Control
 - b. Time Schedule with/without override
 - c. Enthalpy/Analog Comparison
 - d. Analog Comparison
 - e. Interlock / Permissive Interlock
 - f. Fan Control
 - g. Time Schedule with/without override
 - h. Unit Heater
 - i. Constant Volume Air Source control with Demand Controlled Ventilation
 - j. VAV Air Source control with Demand Controlled Ventilation
 - k. WSHP Loop Monitor and Pump Control
 - l. WSHP Loop Cooling – Closed Circuit Tower
 - m. WSHP Loop Cooling – Open Circuit Tower
 - n. WSHP Loop Heating
 - o. Electric Meter with Demand Limit

Communicating Space Sensors

Communicating Space Sensors

Communicating Space Temperature Sensors shall be powered by 12 VDC, wall mounted, and control the room's HVAC (heating, cooling, and ventilation) equipment through RS-485 bus communications. The sensing element shall be enclosed in a plastic housing and shall be a 10,000-ohm thermistor with a range of -4° to 122° F (-20° C to 50° C) and accuracy: $\pm 0.35^{\circ}$ F (0.2° C). All communicating sensors shall have a hidden communication port to allow a handheld service tool access to the controller network.

- a. Where indicated on the plans, provide Plus style sensors which shall be equipped with a sliding setpoint adjustment, an occupancy indicating LED and an override pushbutton.
- b. Where indicated on the plans, provide Pro style sensors which shall be equipped with a liquid crystal display (LCD) with 4 push-button user interface for configuring setpoints and time schedules. Sensors shall store configuration parameters in non-volatile memory and provide coordinated control of the HVAC equipment after a power outage.

In addition to sensing temperature, communicating sensors shall have the following combinations of sensing capabilities:

- Combination Space Temperature / RH Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^{\circ}$ F (0.3° C)
Relative Humidity Range: 10% to 90% Accuracy: $\pm 1.8\%$ typical

- Combination Space Temperature / CO2 Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^\circ$ F (0.3° C)
CO2 Range/Accuracy: 400 to 1250 PPM = ± 30 PPM or 3% of reading, whichever is greater. 1250 to 2000 PPM = $\pm 5\%$ of reading plus 30 PPM
- Combination Space Temperature / VOC Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^\circ$ F (0.3° C)
VOC Range: 0 to 2,000 PPM Accuracy: ± 100 PPM
- Combination Space Temperature / RH / CO2 Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^\circ$ F (0.3° C) Relative Humidity Range: 10% to 90% Accuracy: $\pm 1.8\%$ typical
CO2 Range/Accuracy: 400 to 1250 PPM = ± 30 PPM or 3% of reading, whichever is greater. 1250 to 2000 PPM = $\pm 5\%$ of reading plus 30 PPM
- Combination Space Temperature / RH / VOC Wall Sensors
Temp Range of 50° F to 104° F (10° C to 40° C) Accuracy: $\pm 0.5^\circ$ F (0.3° C)
Relative Humidity Range: 10% to 90% Accuracy: $\pm 1.8\%$ typical
VOC Range: 0 to 2,000 PPM Accuracy: ± 100 PPM

In areas when multiple space conditions are to be measured / controlled, all combinations of sensors shall be provided in one sensor housing and shall be installed on a standard 4" x 2" junction box. Any deviation from this requires written approval from the engineer and architect.

END OF SECTION 230923.13

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Magnetic door holders.
8. Remote annunciator.
9. Addressable interface device.
10. Digital alarm communicator transmitter.

1.2 DEFINITIONS

- A. **Town of Ridgeway – Community Development, Building Inspector/Code Enforcement is to be henceforward referred to as the Authority having jurisdiction (AHJ)**

1.3 CODES AND STANDARDS:

- A. **NFPA Standards 101, 72, 1221, and 90A, latest edition.**
- B. **National Electrical Code, latest edition.**
- C. **2009 International Fire Code and the Local AHJ Fire Code Amendments**
- D. **2009 International Building Code and the Local AHJ Building Code Amendments.**
- E. **Requirements of local Fire Departments.**
- F. **UL Publication.**

1.4 SYSTEM DESCRIPTION

- A. Noncoded, addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.
- B. **The fire alarm system shall provide detection and notification in the paths of egress, common areas to include conference rooms, rest rooms, and apparatus bay. Smoke detection shall be provided over the fire alarm panel, fire alarm battery equipment, and electrical equipment**

rooms. Manual fire alarm pull stations shall be required at all exits of the building. The roll up door from the apparatus bay to the fire house shall be connected to the fire alarm panel and released upon detection. Where the IBC, IFC and local code amendments are more restrictive they shall apply.

1.5 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.6 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design on the specific fire alarm system being installed on this project.
 - b. Person preparing the shop drawings shall be a NICET-certified fire-alarm technician, Level III minimum.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

- D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
- E. Qualification Data: For qualified Installer.
- F. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - 3. Record copy of site-specific software.
 - 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 - 5. Manufacturer's required maintenance related to system warranty requirements.
 - 6. Abbreviated operating instructions for mounting at fire-alarm control unit.
- I. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm technician, Level II minimum.
- ~~C. Source Limitations for Fire Alarm System and Components: Obtain fire alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.~~
- ~~D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.~~

1.8 SOFTWARE SERVICE AGREEMENT A.

Comply with UL 864.

- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following or equally approved:
 - 1. Amseco - a Potter brand; Potter Electric Signal Company.
 - 2. Bosch Security Seystems.
 - 3. Commercial Products Group/CPG Life Safety Signals.
 - 4. Faraday; Siemens Building Technologies, Inc.
 - 5. Federal Signal Corporation.
 - 6. Fire Control Instruments, Inc.; a Honeywell company.
 - 7. Fire Lite Alarms; a Honeywell company.
 - 8. Gamewell; a Honeywell company.
 - 9. GE Infrastructure; a unit of General Electric Company.
 - 10. Gentex Corporation.
 - 11. Harrington Signal, Inc.
 - 12. NOTIFIER; a Honeywell company.

13. Siemens Building Technologies, Inc.; Fire Safety Division.
14. Silent Knight; a Honeywell company.
15. SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
 2. Heat detectors.
 3. Flame detectors.
 4. Smoke detectors.
 5. Duct smoke detectors.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm-notification appliances.
 2. Identify alarm at the fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Release fire and smoke doors held open by magnetic door holders.
 6. Release of drop/shutter rolling steel type fire doors.
 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 9. Activate emergency lighting control.
 10. Activate emergency shutoffs for gas and fuel supplies.
 11. Record events in the system memory.
- C. 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 primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal ac voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
- D. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

2.3 FIRE-ALARM 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 and listed and labeled by an NRTL.

- a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), 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.
 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- 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, three line(s) of 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
 1. Addressable Systems: Notification Appliance, and Signaling Line Circuits:
 - a. Initiating Device Circuits: Class A, ~~Style D~~. (Non Addressable Devices Only)
 - b. Notification Appliance Circuits (NACs): Class B.
 - c. Signaling Line Circuits (SLC): Class A, ~~Style 6~~, Taps not permitted.
 - d. Install no more than 50 addressable devices on each signaling line circuit.
- D. Notification Appliance Circuit: Operation shall sound in a Temporal-Three alarm signal Pattern.
- E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- F. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals shall be powered by 24-V dc source.
 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- G. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: ~~Sealed lead calcium or~~ Sealed, valve-regulated, recombinant lead acid.

- ~~2. Battery Nominal Life Expectancy: 20 years, minimum.~~
- ~~3. Facilities without generator power to the Fire Alarm Control Panel must have 60-hours battery capacity while in the alarm mode for 5 minutes.~~
- ~~4. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails unless restored within 60 seconds.~~

~~H. Battery Charger:~~

- ~~1. Solid state, fully automatic, variable charging rate type.~~
- ~~2. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge.~~
- ~~3. Whenever batteries are fully discharged, the charger shall recharge them completely within four hours.~~
- ~~4. Charger output is supervised as part of system power supply supervision.~~

- I. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

~~J. Air Handling Unit Shutdown Defeat:~~

- ~~1. 1. A supervised "AHU Shutdown Defeat" switch must be provided in or adjacent to the FACP, and as a key-operated function in the Remote Annunciator (where provided).
a. All smoke dampers associated with the AHU(s) shall remain in the open position while the AHU Shutdown Defeat switch has been placed in the off-normal position.~~
- ~~2. Whenever the Remote Annunciator option is utilized, provide an informative engraved label at the FACP about this function.~~
- ~~3. The switch must cause a system "trouble" indication when it's placed in the off-normal ("AHU Shutdown Defeated") position.~~

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for 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. Single-action mechanism, pull-lever type. With integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
- ~~2. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod and pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.~~
3. Station Reset: Key- or wrench-operated switch.
- ~~4. 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.~~
- ~~5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.~~

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be ~~two~~ **four** wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - 1. Mounting: Adapter plate for outlet box mounting or Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
 - 1. Mounting: Adapter plate for outlet box mounting or Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. 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.
- B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output. C.
Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- E. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.
 - 1. Rated Light Output:
 - a. 15, 30, 75, 110, or 177 cd.
 - b. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished red or white.

~~2.8~~ MAGNETIC DOOR HOLDERS

~~A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.~~

- ~~1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.~~
- ~~2. Wall Mounted Units: Flush mounted unless otherwise indicated.~~
- ~~3. Rating: 24 V ac or dc.~~
- ~~4. Rating: 120 V ac.~~

~~B. Material and Finish: Match door hardware.~~

2.9 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush or Surface cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to AHU starter, smoke damper operation, elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.

1. Smoke Damper operation: Provide additional relay with sufficient make-break rating at 120VAC or 277VAC to energize and de-energize individual smoke dampers. Coordinate with Mechanical Contractor for damper electrical characteristics.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be

transmitted. If service on either line is interrupted for longer than ~~45~~ **90** seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address, Zone of the supervisory signal.
 - 3. Address, Zone of the trouble-initiating device.
 - 4. Loss of AC supply or loss of power.
 - 5. Low battery.
 - 6. Abnormal test signal.
 - 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

~~2.12~~ — WIRING

- ~~A. Non-Power Limited Circuits: Copper conductors with 600-V rated, 75 deg C, color-coded THHN/THWN insulation.~~
 - ~~1. Low Voltage Circuits: Stranded No. 12 AWG, minimum.~~
 - ~~2. Line Voltage Circuits: Solid No. 12 AWG, minimum.~~
- ~~B. Power Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.~~
- ~~C. Wiring shall be color coded as follows:~~
 - ~~1. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, low capacitance (30 pF Max.), 18 AWG minimum, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable manufacturers include Atlas, Belden, West Penn or equal wire having capacitance of 30 pF/ft. maximum between conductors. The cable jacket color shall be red, with Red (+) and Black (-) conductor insulation.~~

2. ~~Unshielded Cable, otherwise equal to the above, is permitted where the manufacturer's installation instructions unequivocally require, or state a preference for, the use of unshielded cable for all systems.~~
3. ~~Alarm notification appliance circuits (horns and strobes) shall be wired with type THHN/THWN, stranded copper, AWG 12 minimum, color coded Blue (+), Black (-) conductor insulation.~~
4. ~~One way voice/Alarm and Two way (Fireman's Telephone) digital audio circuits shall be wired with low capacitance (30-pF Max.), AWG 12 minimum, twisted shielded copper pair. Cable shield drain wires are to be connected continuous from the amplifier to the end of the line. Acceptable manufacturers include Atlas, Belden, West Penn or equal wire having capacitance of 30 pf/ft. maximum between conductors. The cable jacket shall be Gray outer jacket, Red (+), Black (-) conductor insulation.~~
 - a. ~~Note: Where required to meet NFPA fire rating requirements MI cable shall be utilized.~~
5. ~~System equipment with 24VDC operating power shall be wired with type THHN/THWN, stranded copper, AWG 12 minimum, color coded Yellow (+), Brown (-) conductor insulation.~~
6. ~~Door control circuits for maglocks if supplied from fire alarm system shall be wired with type THHN/THWN, stranded copper, AWG 12 minimum, color coded Orange conductor insulation.~~
7. ~~Circuits from Zone Addressable Monitored Devices shall be wired with type THHN/THWN, stranded copper, AWG 12 minimum, color coded Violet (+), Gray (-) conductor insulation.~~
8. ~~For underground circuits installed in conduit, use Type TC or PLTC cable (PE insulated) to avoid problems for moisture. Color coding for specific application, as described herein, shall be followed.~~

2.13 POWER SUPPLIES

- A. ~~Notification Appliance circuit booster ("ADA") power supplies must be individually monitored for integrity and are not permitted to be located above a ceiling, or in non-conditioned space. Any 24vdc power circuits serving addressable control relays must also be monitored for integrity. Provide a smoke detector within 15 feet of the power supply.~~
 1. ~~Each Power Booster shall be addressable to and supervised, per NFPA requirements, by the FACP.~~
 2. ~~The FACP shall be able to distinguish each individual Power Booster and issue a digital readout for each individual Power Booster that reports a trouble signal.~~
 3. ~~Provide dedicated 120-volt receptacle from the same source as the FACP.~~

2.14 ISOLATION MODULES

- A. ~~To minimize the impact of a wiring fault (short), isolation modules or (if the ceiling height is <10 feet) isolator base type initiating devices shall be provided as follows:~~
 1. ~~After each 20 devices and control points on any addressable circuit.~~
 2. ~~For each addressable circuit that extends outside the building walls.~~

- ~~3. Immediately adjacent to the FACP, at each end of the addressable loop. These two isolators must be in the same room as the FACP and within 15 feet. Isolation modules shall not be located in the FACP.~~
- ~~4. For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolator(s) on any floor with over 20 addresses).~~
- ~~5. Coordinate with the Owner and the Engineer for the approved method of installation for accessibility and maintenance.~~

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment. B.

Control Relays:

1. Control relays shall be installed to meet NFPA requirements. This shall include but not limited to control relays that actuate smoke and/or fire dampers and motors associated with smoke exhaust/removal systems.
 - a. The maximum distance from the fire alarm control relay to the motor controller or smoke/fire damper shall be 3-ft.

- C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A and/or Appendix B in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

- D. Smoke detector: Mount photoelectric smoke detector within 15' of the central FACP and each external power supply.

- E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector.

1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
2. Install sampling tubes so they extend the full width of the duct.

3. Where installed to close smoke dampers, install within 5 feet of damper with no air outlets or inlets between detector and damper. Detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed. Smoke damper shall close upon actuation of smoke detector.
- F. Manual Pull Stations: Mount semi-flush in recessed back boxes. Mount 48" AFF to top of device.
1. Coordinate with the general contractor for installation of devices required by code to be within 5-ft of exit doors.
 - a. Method of installing fire alarm cables through mullions of curtain wall systems.
 - 1) Submit to the Engineer and Engineer for approval installation drawings showing methods to be used for routing of cables and device mounting.
- G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.
- L. Annunciator: Install with top of panel not more than 72 inches above the finished floor.
- M. Digital dialer: Provide two (2) data outlet jacks compatible with the digital dialer, including data cabling as specified in these specifications (Category 5e minimum rating). Connect to the local floor telecommunications equipment as specified in these specifications. Install in ½" conduit minimum from outlet jacks to telecommunications equipment.
- N. Smoke Detector Protection: Unless suitable protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be replaced.
- O. Detector Identification: Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop#-- Device#) Put on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: for detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements of model building codes. Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet 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 firefighter smoke-control system panel.
 - 2. Alarm-initiating connection to activate emergency lighting control.
 - 3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

3.3 WIRING INSTALLATION

- A. Installer Qualifications: All persons terminating wiring, installing fire alarm system devices and /or programming the fire alarm systems shall meet the following minimum requirements:
 - 1. Trained and certified by manufacturer in fire-alarm system design on the specific fire alarm system being installed on this project.
 - a. The factory training and certification must have occurred within the most recent 24 months. The manufacturer must sign the certification certifying the installer's compliance with their requirements.
 - b. Copies of the certification must be part of the Contractor's submittal to the Engineer prior to installation.
 - c. The submittal will not be approved without this certification.
 - 2. In addition to the requirement for factory certification the person preparing the shop drawings shall be a NICET-certified fire-alarm technician, Level III minimum.
- B. Wiring Method: Install wiring in metal raceway according to NFPA 70 "Raceways and Boxes." Conceal raceway except in unfinished spaces and as indicated.
 - 1. Coordinate with the general contractor for installation of devices required by code to be within 5-ft of exit doors.
 - a. Method of installing fire alarm cables through mullions of curtain wall systems.
 - 1) Submit to the Engineer for approval installation drawings showing methods to be used for routing of cables and device mounting.
 - 2. All Class A SLC loop circuits, as required herein, shall have the supply and return 'loop' cables installed in separate raceways to insure survivability except as noted herein.

- a. On multi-story buildings each floor shall have a dedicated Class A SLC loop.
 - b. Minimum separation distance between the Class A SLC supply and return raceways/cables shall be the corridor width, less 1-ft., for the floor being served by the Class A SLC loop.
 - 1) Exception: The supply and return Class A loop cables may occupy the same raceway from the junction box where the SLC initiating device is mounted for a maximum distance of 6-ft. where they shall enter into a common junction box where they shall be installed in separate raceways to the next device on the loop, fire alarm terminal cabinet or fire alarm control panel.
 - c. As an option on multi-story buildings, the Class A SLC supply and return raceways may be installed so that the Class A SLC loop cables terminate in fire alarm terminal cabinets located at opposite ends of the floor being served by a Class A SLC loop. From the terminal cabinets on each floor the supply and return loop cables shall be installed in raceways containing only SLC cables and shall be routed to the next fire alarm terminal cabinet on a lower floor or directly back to the fire alarm control panel.
 - d. The supply and return Class A SLC loop cables/raceways shall be kept separated back to within 10-ft. from where they enter the fire alarm control panel.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer.
- 1. All wiring and splices shall be made using terminal blocks. Crimp type connectors or 'wire nuts' connectors are prohibited.
 - 2. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.
 - 3. All terminal blocks shall be securely fastened in place using screws. Adhesive tape or glue will not be acceptable.
 - 4. Run fire alarm system wiring in dedicated raceway system containing only fire alarm system wiring.
 - 5. Install conductors parallel with or at right angles to sides and back of the enclosure.
 - 6. Bundle, lace, and train conductors to terminal points with no excess.
 - 7. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks.
 - 8. All doors of all enclosures shall contain a green insulated #12 copper conductor bonding the enclosure to the door. This shall not impede opening of the door to 180 degrees.
 - 9. Mark each terminal according to the system's wiring diagrams.
 - 10. Make all connections with approved crimp-on terminal spade lugs, screw terminal blocks, or plug connectors.
 - 11. Label all wires at all termination points.
 - 12. Label inside of enclosure with 120 VAC source panel board and circuit number.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification per the NEC.
 - 1. All system wiring shall be labeled at each termination point or splice.

- B. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch (25 mm) high. Identify individual components and modules within cabinets with permanent labels.
- C. Install Instructions frame in a location visible from the FACP.
- D. Label Central FACP with engraved label indicating panel location, panel name, and circuit number of power source to FACP.
- E. It is understood that the room names and numbers shown on the contract document may change prior to the final acceptance of the building by the Owner.
 - 1. The installing contractor shall coordinate with the Owner and/or the General Contractor the final room names and numbers for the entire building. This shall occur prior to the final Engineer's acceptance testing.
 - 2. The FACP programming and subsequent display readouts shall indicate these room names, numbers and identical device addresses in order as follows:
 - a. Device type.
 - b. Equipment or unit number associated with the device whenever applicable.
 - c. Location by room number.
 - d. Device address number.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground the enclosure doors using a green insulated #12 grounding conductor attached to the enclosure housing and the door. Install so that the door is free to swing open 180- degrees.
- C. The Fire Alarm Control Panel shall be grounded to the AC supply source with an insulated equipment grounding conductor installed and routed in the same raceway with the AC branch circuit conductors feeding the Fire Alarm Control Panel.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Owner Representative and/or Authority Having Jurisdiction
- B. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 FINAL DOCUMENTATION

- A. After all system corrections have been made provide to the engineer the following documentation.
1. Riser diagram(s) showing all fire alarm panels, power booster panels, fire alarm devices and terminal boxes. The diagram shall represent how the devices are connected to the fire alarm system and shall be suitable for trouble shooting the fire alarm system connections.
 2. Documentation shall be provided in CAD file format compatible with the engineer's CAD files for the project.
 3. The contractor shall make all corrections to the file(s) as directed by the engineer.

3.8 GUARANTEE:

- A. All wiring, etc., shall be in strict accordance with the local Electrical Code requirements and shall have the written approval of all public authorities having jurisdiction. The Contractor shall guarantee all equipment and wiring free from inherent mechanical and electrical defects for a period of one (1) years from date of installation. The final connection between the equipment and wiring system and all programming shall be made under the direct supervision of a qualified technical representative of the manufacturer. All products of combustion detectors shall have sensitivities set by Factory Trained Technician, and results submitted to the Engineer.

3.9 DEMONSTRATION

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

3.10 TRAINING:

- A. Training shall cover the following topics at a minimum:
 - 1. Preventative maintenance service techniques and schedules, including historical data trending of alarm and trouble records.
 - 2. Overall system concepts, capabilities, and functions. Training shall be in-depth, so that the owner shall be able to add or delete devices to the system and to take any device out of service and return any device to service without need for Manufacturer's approval.
 - 3. Explanation of all control functions, including training to program and operate the system software.
 - 4. Methods and means of troubleshooting and replacement of all field wiring and devices.
 - 5. Methods and procedures for troubleshooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry and interconnections.
 - 6. Manuals, drawings, and technical documentation. Actual system software used for training shall be provided on a digital file storage format and shall be left with the Owner at the completion of training for the Owner's use in the future.

PART 4 - NFPA FORMS

4.1 FIRE ALARM SYSTEM CERTIFICATION OF COMPLETION.

- A. Complete the latest revised NFPA 72-2002, Figure 4.5.2.1, "Record of Completion" Form.
 - 1. On the form, place the installers name and NICET number or factory authorized certification number of installing technician who is responsible for certifying the installation of the fire alarm system.
- B. Submit to Engineer for review prior to Engineer's scheduled acceptance testing.

END OF SECTION 283111