VOLUME TWO

DIVISIONS 21 THRU 33

GODARE HALL RENOVATIONS

for

Vincennes University
Vincennes, Indiana

Construction Documents

Gibraltar Design Project Number: 26-115
Date: September 1, 2026

GIBRALTAR
DESIGN
ARCHITECTURE ENGINEERING INTERIOR DESIGN
9102 North Meridian Street, Suite 300
Indianapolis, Indiana 46260
Homepage: www.GibraltarDesign.com
Email: Info@GibraltarDesign.com
Phone: 317.580.5777 FAX: 317.580.5778

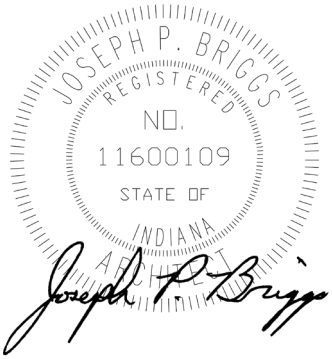
GODARE HALL RENOVATIONS

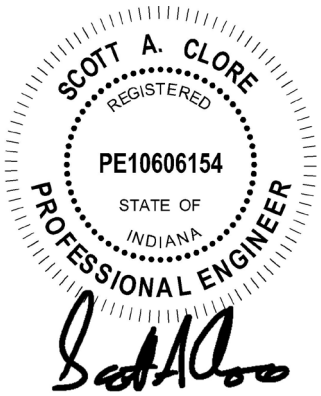
for

Vincennes University

Vincennes, Indiana

Gibraltar Design Project Number: 26-115
Date: September 1, 2026





SECTION 00 01 10
TABLE OF CONTENTS

Division Title

SECTION NO. SECTION TITLE

VOLUME ONE

Division 00 Procurement and Contracting Requirements

00 11 00 **Invitation to Bidders**
00 21 00 Instructions to Bidders
Substitution Request Form
00 30 00 Certification of Non-Segregated Facilities
Bid Form
Subcontractors and Products List
MBE/WBE/VBE Report
E-Verify Affidavit
AIA A201 General Conditions of the Contract for Construction
00 73 16 Exhibit A – Supplemental General Conditions

Division 01 General Requirements

01 11 00 Administrative Provisions
01 12 00 Multiple Contract Summary
01 21 00 Allowances
01 22 00 Unit Prices
01 23 00 Alternates
01 26 00 Contract Modification Procedures
01 29 00 Payment Procedures
01 31 17 Project Meetings
01 32 00 Progress Schedule
01 33 00 Submittals
01 45 00 Quality Control
01 50 00 Temporary Facilities and Controls
01 51 13 Temporary Electricity
01 51 23 Temporary Heating, Cooling, and Ventilating
01 51 26 Temporary Lighting
01 51 36 Temporary Water
01 56 39 Tree and Plant Protection
01 61 00 Material and Equipment
01 71 23 Field Engineering
01 71 24 Work Layout
01 73 29 Cutting and Patching
01 74 13 Construction Cleaning
01 77 00 Contract Closeout

Division 02 Existing Conditions

02 41 20 Removals
02 41 30 Minor Demolition for Remodeling

Division 03 Concrete

03 30 00 Concrete

Division 04 Masonry

04 01 00 Masonry Restoration and Cleaning
04 20 00 Unit Masonry

Division 05 Metals

05 12 00 Structural Steel
05 31 23 Steel Roof Deck
05 40 00 Cold Formed Metal Framing
05 50 00 Miscellaneous Metals
05 52 16 Aluminum Railings

Division 06 Wood, Plastics, and Composites

06 10 00 Rough Carpentry
06 20 00 Finish Carpentry
06 61 16 Solid Surfacing Fabrications

Division 07 Thermal and Moisture Protection

07 21 16 Batt and Blanket Insulation
07 21 19 Foamed-In-Place Insulation
07 53 23 Roof Patching
07 62 00 Sheet Metal Flashing
07 84 00 Firestopping
07 90 00 Joint Sealants

Division 08 Openings

08 11 13 Standard Steel doors and Frames
08 14 16 Wood Doors
08 31 13 Access Doors
08 41 00 Aluminum Entrances and Storefronts
08 71 00 Door Hardware
08 81 00 Glazing

Division 09 Finishes

09 22 13 Metal Framing and Furring
09 23 00 Cement Plaster Veneer
09 27 13 Prefabricated Column Cover
09 29 00 Gypsum Board
09 31 00 Ceramic Tile
09 51 00 Acoustical Ceilings
09 65 13 Resilient Flooring
09 67 21 Epoxy Flooring
09 68 00 Carpet

09 72 16 Wall Covering
09 84 00 Acoustical Wall Panels
09 91 00 Painting

Division 10 Specialties

10 11 00 Markerboards and Corkboards
10 21 14 Solid Plastic Toilet Partitions
10 26 00 Wall Protection
10 28 13 Toilet Accessories
10 44 00 Fire Extinguishers and Cabinets

Division 11 Equipment

NOT USED

Division 12 Furnishings

12 25 00 Roller Shades
12 32 16 Plastic Laminate Casework

Division 13 Special Construction

NOT USED

Division 14 Conveying Equipment

NOT USED

VOLUME TWO

Division 21 Fire Suppression

21 05 00 Common Work Results for Fire Suppression
21 10 00 Water-Based Fire Suppression Systems

Division 22 Plumbing

22 05 00 Common Work Results for Plumbing
22 05 19 Meters and Gages for Plumbing Piping
22 05 23 General-Duty Valves for Plumbing Piping
22 05 29 Hangers and Supports for Plumbing Piping and Equipment
22 05 48 Vibration & Seismic Controls for Plumbing Piping and Equipment
22 05 53 Identification for Plumbing Piping and Equipment
22 07 00 Plumbing Insulation
22 11 16 Domestic Water Piping
22 11 19 Domestic Water Piping Specialties
22 13 16 Sanitary Waste and Vent Piping
22 13 19 Sanitary Waste Piping Specialties
22 31 00 Domestic Water Softeners
22 40 00 Plumbing Fixtures

Division 23 Heating Ventilating and Air Conditioning

23 05 00 Common Work Results for HVAC
23 05 13 Common Motor Requirements for HVAC Equipment
23 05 17 Sleeves and Sleeve Seals for HVAC Piping
23 05 18 Escutcheons for HVAC Piping
23 05 19 Meters and Gages for HVAC Piping
23 05 23 General-Duty Valves for HVAC Piping
23 05 25 Roof Curbs
23 05 29 Hangers and Supports for HVAC
23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment
23 05 53 Identification for HVAC Piping and Equipment
23 05 93 Testing, Adjusting, and Balancing for HVAC
23 07 13 Duct Insulation
23 07 16 HVAC Equipment Insulation
23 07 19 HVAC Piping Insulation
23 09 00 Instrumentation and Control for HVAC
23 09 93 Sequence of Operations
23 21 13 Hydronic Piping
23 21 23 Hydronic Pumps
23 25 00 HVAC Water Treatment
23 31 13 Metal Ducts
23 32 00 Louvers and Vents
23 33 00 Air Duct Accessories
23 34 00 Fans, Exhausters, and Ventilators, General
23 37 13 Diffusers, Registers, and Grilles
23 64 25 Air Cooled Scroll Liquid Chiller
23 65 00 Cooling Towers
23 74 33 Dediated Outdoor-Air Units
23 81 26 Ductless Split System Units
23 81 46 Water Source Unitary Heat Pumps
23 82 19 Fan Coil Units
23 82 39 Unit Heaters

Division 26 Electrical

26 05 00 Common Work Results for Electrical
26 05 19 Low-Voltage Electrical Power Conductors and Cables
26 05 26 Grounding and Bonding for Electrical Systems
26 05 29 Hangers and Supports for Electrical Systems
26 05 34 Conduit
26 05 37 Boxes
26 05 53 Identification for Electrical Systems
26 05 83 Electrical Connections to Equipment
26 09 23 Lighting Control Devices
26 24 16 Panelboards
26 27 26 Wiring Devices
26 28 16 Disconnect Switches
26 28 17 Enclosed Switches and Circuit Breakers
26 50 00 Lighting

Division 27 Communications

27 05 00 Common Work Results for Communications
27 05 01 Pathway for Communication Systems
27 05 02 Sleeves and Sleeve Seals for Communication Pathways and Cables
27 05 03 Communications Equipment Room Fittings
27 05 04 Communications Backbone Cabling
27 05 05 Cable Trays for Communication
27 05 06 Telecommunications Grounding and Bonding
27 15 00 Communications Copper Horizontal Cabling

Division 28 Electronic Safety and Security

28 00 13 Access Control System
28 31 00 Fire Detection and Alarm

Division 31 Earthwork

31 23 16 Excavation
31 23 16 Trenching
31 23 23 Backfilling

Division 32 Exterior Improvements

32 13 13 Portland Cement Concrete Paving
32 92 00 Turf and Grasses
32 92 02 Restoration of Surfaces

Division 33 Utilities

33 30 00 Sanitary Sewage Systems

END OF SECTION

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Fire-suppression equipment and piping demolition.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.
2. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 SLEEVES

A. Mechanical Sleeve Seals: Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Galvanized-Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. PVC Pipe: ASTM D 1785, Schedule 40.

2.5 ESCUTCHEONS & FLOOR PLATES

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed or exposed-rivet hinge, and spring-clip fasteners.

D. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

E. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATIONS

A. Fire Suppression Contractor shall be responsible for coring suspended ceiling tiles, to accommodate sprinkler heads.

B. Install piping free of sags and bends.

C. Install fittings for changes in direction and branch connections.

D. Sleeves:

1. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
2. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
3. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

E. Escutcheons & Floor Plates:

1. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
2. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
3. Install floor plates for piping penetrations of equipment-room floors.
4. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

F. Install unions at final connection to each piece of equipment.

END OF SECTION 21 05 00

SECTION 21 10 00 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Contractor shall extend/expand the existing building's fire suppression system – and ensure system is fully operational – to meet all applicable jurisdictional requirements, including State Fire Marshal & City of Vincennes.

B. This Section includes the following fire-suppression piping inside the building:

1. Wet-pipe sprinkler systems.

C. Related Sections include the following:

1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig. All components shall be UL and FMG approved.

B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction and the Owner's insuring agency.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:

1. Mechanical Room (First Floor): Ordinary Hazard, Group 1
2. Electrical Room (First Floor): Ordinary Hazard, Group 1
3. Electrical Closets (4 Closets per Floor): Ordinary Hazard, Group 1
4. Sleeping Rooms, Corridors, Office & Public Space: Light Hazard

3. Minimum Density for Automatic-Sprinkler Piping Design:

    1. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
    2. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
    3. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 2000-sq. ft. area.

4. Maximum Protection Area per Sprinkler:

    1. Mechanical Room: 130 sq. ft.
    2. Electrical Room & Closets: 130 sq. ft.
    3. Sleeping Rooms, Corridors, Office & Public Space: 225 sq. ft.
    4. Extended coverage heads shall not be utilized.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:

    1. Light-Hazard Occupancies: 100 gpm
    2. Ordinary-Hazard Occupancies: 250 gpm

1.5 SUBMITTALS

A. Product Data: For the following:
1. Piping materials, including sprinkler specialty fittings.
2. Pipe hangers and supports.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
5. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
6. Alarm devices, including electrical data.

B. Fire-hydrant flow test report.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 20. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

E. Welding certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.7 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

2.3 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865.

B. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller.

1. Grooved-Joint Piping Systems:

1. Manufacturers

1) Gruvlok
2) Star Pipe Products; Star Fittings Div.
3) Victaulic Co. of America.

2. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

3. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

C. Threadable thin wall pipe and Schedule 5 pipe and Schedule 7 pipe shall not be utilized.

2.4 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed and FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Outlet Specialty Fittings:

1. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
2. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed and FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum 300-psig pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, non-rising stem, operating nut, and flanged ends.
2. Manufacturers:

1. Grinnell Fire Protection.
2. McWane, Inc.; Kennedy Valve Div.
3. NIBCO.
4. Victaulic Co. of America.
5. Reliable Automatic Sprinkler Co., Inc.

C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Star Sprinkler Inc.
3. Stockham.

D. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

1. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

1. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) Milwaukee Valve Company.

2.6 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.7 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed and FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

1. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

    1. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
    2. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.8 SPRINKLERS

A. Sprinklers in reflective ceiling tile to be white concealed sprinklers.

B. Sprinklers in drywall ceiling tile to be white concealed sprinklers.

C. Sprinklers in “connector wing” corridors, with wood finish ceiling, to be black concealed sprinklers.

D. Sprinklers exposed to view to be brass upright or pendant.

E. Manufacturers
    1. Reliable Automatic Sprinkler Co., Inc.
    2. Viking.
    3. TYCO.
    4. Victaulic Co. of America.

2.9 FIRE DEPARTMENT CONNECTIONS

A. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA requirements and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

    1. Type: Flush, with two inlets and square or rectangular escutcheon plate.
    2. Type: Exposed, projecting, with two inlets and round escutcheon plate.
    3. Finish: Rough chrome-plated.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm: UL 464, with 10-inch- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation.

Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

2.11 PRESSURE GAUGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge.
2. Dresser Equipment Group; Instrument Div.
3. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 300 psig.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.4 PIPING APPLICATIONS, GENERAL

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with and threaded grooved-end fittings; joints.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
1. NPS 2 and Smaller: Threaded-end, black or galvanized, standard weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
2. NPS 2-1/2 and Larger: Grooved, Schedule 10 steel pipe; grooved fittings; and grooved joints.
3. Threadable thinwall and Schedule 5 and Schedule 7 pipe shall not be utilized.

3.6 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 20.

1. Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 20.

1. Shutoff Duty: Use ball, butterfly, or gate valves.
2. Throttling Duty: Use ball or globe valves.

3.7 JOINT CONSTRUCTION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40.

C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.

1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 WATER-SUPPLY CONNECTION

A. Connect fire-suppression piping to building's interior water distribution piping at a point 12" AFF inside the building. Refer to Division 22 Section "Domestic Water Piping" for interior piping.

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water distribution piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water supply.

D. Fire sprinkler contractor shall be required to install and test the FDC to the exterior location.

3.9 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

E. Install sprinkler piping with drains for complete system drainage.

F. Install drain valves on standpipes.

G. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

H. Install alarm devices in piping systems.

I. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install sprinkler system piping according to NFPA 13 and Owner's insuring agency guidelines.

J. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

K. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gauges to permit removal, and install where they will not be subject to freezing.

L. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 20 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Valves for Wall-Type Fire Hydrants: Install non rising-stem gate valve in water-supply pipe.

D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

E. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install pedestal -type, fire department connections as shown on the drawing.

B. Install freestanding-type, fire department connections in level surface.

1. Install protective pipe bollards on two sides of each fire department connection. Refer to Division 05 Section "Metal Fabrications" for pipe bollards.

C. Install ball drip valve at the check valve for fire department connection.

3.12 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Electrical Connections: Power wiring is specified in Division 26.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.13 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 20.

3.14 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Energize circuits to electrical equipment and devices.
4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
5. Coordinate with fire alarm tests.
6. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.15 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.16 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 21 10 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Temporary water service during construction.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

B. Related Sections:

1. Division 01 Section Project Management and Coordination for requirements related to each sub contractor's responsibility to complete coordination drawings and submit.
2. Division 01 78 39 Section Project Record Documents for requirements related to each sub contractor's responsibility to submit record drawing to the owner as part of the operation and maintenance data (section 017823).
3. Division 230500-1.3 coordination.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 WARRANTY

A. Provide (1) year parts and labor, (5) year for compressors unless otherwise noted.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Plastic Carbon steel Stainless steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 TEMPORARY WATER SERVICE

A. Provide a metered, domestic water connection for site use following the installation of the water main.

B. Repair leaks for a water tight installation.

C. Protect water service from freezing conditions using electrical heat tape or other means.

D. Install at least one valved hose connection for use by all personnel on site.

E. Comply with municipal requirements regarding water service and usage.

3.2 PIPING SYSTEMS – COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported

equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Galvanized-steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.
c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.12 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

END OF SECTION 22 05 00

SECTION 22 05 19 – METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dial-type pressure gages.
2. Gage attachments.
3. Domestic sub-meter.

1.2 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. AMETEK, Inc.; U.S. Gauge.
b. Ashcroft Inc.
c. Ernst Flow Industries.
d. Flo Fab Inc.
e. Marsh Bellofram.
f. Miljoco Corporation.
g. Noshok.
h. Palmer Wahl Instrumentation Group.
i. REOTEMP Instrument Corporation.
j. Tel-Tru Manufacturing Company.
k. Trerice, H. O. Co.
l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
m. Weiss Instruments, Inc.
n. WIKA Instrument Corporation - USA.
o. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Sealed Open-front, pressure relief Solid-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal Brass Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.2 DOMESTIC WATER SUBMETER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Badger Meter.

B. Features:

1. Nutating disc meter.
2. Bronze.
3. Maximum pressure: 150 psi.
4. Maximum temperature: 250°F.

2.3 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

B. Install valve and snubber in piping for each pressure gage for fluids.

C. Install pressure gages in the following locations:

1. Building water service entrance into building

D. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

E. Adjust faces of meters and gages to proper angle for best visibility.

3.2 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.

B. Scale Range for Domestic Water Piping: 0 to 100 psi.

3.3 DOMESTIC SUBMETER

A. Provide full-pipe-size submeter at each make-up water & blowdown locations.

B. Provide strainer upstream of each submeter.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Bronze gate valves.
8. Iron gate valves.
9. Bronze globe valves.
10. Iron globe valves.
11. Chainwheels.

B. Related Sections:

1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
3. Section 221319 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.
4. Section 221423 "Storm Drainage Piping Specialties" for valves applicable only to this piping.

1.2 QUALITY ASSURANCE

A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

C. All valves to be certified lead free.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height above 6 ft AFF.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.

2. Description:

    a. Standard: MSS SP-110.
    b. SWP Rating: 150 psig.
    c. CWP Rating: 600 psig.
    d. Body Design: Two piece.
    e. Body Material: Forged brass.
    f. Ends: Threaded.
    g. Seats: PTFE or TFE.
    h. Stem: Brass.
    i. Ball: Chrome-plated brass.
    j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. American Valve, Inc.
    b. Conbraco Industries, Inc.; Apollo Valves.
    c. Crane Co.; Crane Valve Group; Crane Valves.
    d. Hammond Valve.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Red-White Valve Corporation.
    h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-110.
    b. SWP Rating: 150 psig.
    c. CWP Rating: 600 psig.
    d. Body Design: Two piece.
    e. Body Material: Bronze.
    f. Ends: Threaded.
    g. Seats: PTFE or TFE.
    h. Stem: Bronze.
    i. Ball: Chrome-plated brass.
    j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements)::

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. NIBCO INC.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and weight.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements)::

   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.

   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   k. Zy-Tech Global Industries, Inc.

2. Description:

   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements)::

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.10 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.

1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

F. Install isolation valves on each cold & hot water feed serving fixtures. Valves shall be installed directly above the fixture, in an accessible location.

G. In lieu of individual isolation valves over each lavatory, water closet, & shower in the dormitory rooms/bathrooms, install isolation valves in corridor, on the (2) feeds into each dormitory room/bathroom – CWS & HWS. These valves will allow shutdown over the entire dormitory room/bathroom.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking

occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, or butterfly valves.
2. Throttling Service: Ball, or butterfly valves.
3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.

c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and brass: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bonze and brass trim.
3. Bronze Swing Check Valves: bronze.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.

END OF SECTION 22 05 23

SECTION 22 05 29 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Coatings, where designated:

    a. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
    b. Nonmetallic Coatings: Plastic coating, jacket, or liner.

3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium
silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building

attachments where required in concrete construction.

P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each product indicated.
2. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D
2. Building Seismic Design Category: C
3. Assigned Seismic Risk Category as Defined in the IBC: III.

    a. Component Importance Factor: 1.0. To be determined from ASCE 07-10 section 13.1.1 for each component type
    b. Component Response Modification Factor: 2.5. To be determine from ASCE 07-10 Table 13.6-1 for each component type
    c. Component Amplification Factor: 2.5. To be determine from ASCE 07-10 Table 13.6-1 for each component type

4. Design Spectral Response Acceleration at Short Periods (0.2 Second): 43.3%g.
5. Design Spectral Response Acceleration at 1-Second Period: 23.1%g.

2.2 VIBRATION ISOLATORS

A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

B. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.3 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

C. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

PART 3 - EXECUTION

3.1 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

G. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 22 05 48

SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to

three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data, both electronically & hard copy.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and debris.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Coordinate installation of identifying devices with locations of access panels and doors.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment. Radon vent piping reduce intervals to 10 feet.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels. B.

B. Pipe Label Color Schedule:

1. Domestic Water Piping:

   a. Background Color: White.
   b. Letter Color: Black.

2. Sanitary Waste, Vent and Storm Drainage Piping:

   a. Background Color: White.
   b. Letter Color: Green.

3. Fire Protection

   a. Background Color: White.
   b. Letter Color: Red.

4. Gas Piping:

   a. Background Color: Yellow
   b. Letter Color: Black

C. Ceiling Label:

1. Provide small colored decal on ceilings, directly underneath valves. Coordinate decal size, shape, & color with Owner.

END OF SECTION 22 05 53

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.
2. For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less according to ASTM E 84.

B. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less according to ASTM E 84.

2.2 INSULATION MATERIALS

A. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

B. 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.

C. Mineral-Fiber Blanket Insulation: Comply with ASTM C 553, Type II and ASTM C 1290, Type I.

D. Mineral-Fiber, Preformed Pipe Insulation: Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.

E. Mineral-Fiber, Pipe and Tank Insulation: Complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB; and having factory-applied ASJ. 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.

F. Polyolefin Insulation: 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.

2.3 ADHESIVES

A. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less.

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

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less.

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

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less.

2.4 MASTICS

A. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less.
2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
5. Color: White.

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less.

B. ASJ Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less.

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.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

PART 3 - EXECUTION

3.1 PIPE INSULATION INSTALLATION

A. Comply with requirements of the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards" for insulation installation on pipes and equipment.

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

C. Insulation Installation at Fire-Rated Wall, Partition, and Floor Penetrations: Install insulation continuously through penetrations. Seal penetrations. Comply with requirements in Section 078413 "Penetration Firestopping."

D. Flexible Elastomeric Insulation Installation:

1. Seal longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Mineral-Fiber Insulation Installation:

1. Insulation Installation on Straight Pipes and Tubes: Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
2. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
3. 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.

F. Polyolefin Insulation Installation:

1. Seal split-tube longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of polyolefin pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

G. Interior Piping System Applications: Insulate the following piping systems:

1. Domestic hot water.
2. Recirculated domestic hot water.
3. Roof drain bodies and horizontal rainwater leaders of storm water piping.
4. Exposed water supplies and sanitary drains of fixtures for people with disabilities.

H. Do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Sanitary drainage and vent piping.
3. Drainage piping located in crawlspaces unless otherwise indicated.
4. Chrome-plated pipes and fittings, except for plumbing fixtures for people with disabilities.
5. Piping specialties, including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.2 INDOOR PIPING INSULATION SCHEDULE

A. Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawlspaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

B. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
c. Polyolefin: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
c. Polyolefin: 1 inch thick.

3. Any domestic cold water piping located within an exterior wall shall receive 1-1/2" thick insulation, regardless of pipe size.

C. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
c. Polyolefin: 1 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1-1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
c. Polyolefin: 1-1/2 inch thick.

3. Any domestic hot water piping located within an exterior wall shall receive 1-1/2" thick insulation, regardless of pipe size.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
c. Polyolefin: 1 inch thick.

E. Interior Storm Piping (PVC pipe)

1. All Pipe Sizes: Insulation shall be the following:

    a. Flexible Elastomertic: 1" thick.

F. Exposed Sanitary Drains, Domestic Cold Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

    a. Flexible Elastomeric: 1/2 inch 1 inch thick.
    b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

G. Domestic hot-water heat exchanger, storage tank and expansion tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:

1. Cellular glass: 1" thick
2. Mineral-Fiber Board: 3-lb/cu. ft. nominal density: 1" thick
3. Mineral-fiber pipe and tank: 1" thick

END OF SECTION 22 07 00

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Transition fittings
4. Dielectric fittings
5. Flexible connectors.
6. Water meter.
7. Reduced-pressure backflow preventers.

B. Related Section:

1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.2 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61 for potable domestic water piping and components.

D. All piping shall be tested for working pressure of 150 psi minimum and temperature of 210 degree Fahrenheit, as required by Minnesota code.

E. Water service line must be installed at least 10 feet horizontally from any manhole, catchbasin, or any other potential source of contamination (see Minnesota Rules, part 4715.1710, subpart 3).

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tubing: ANSI H23.1, ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

B. Soft Copper Tube: ANSI H23.1, ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ANSI H23.1, ANSI B16.22, ANSI B1618, ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASTM B62, ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. ANSI A21.15 compliant.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. ANSI A21.15 compliant.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. ANSI A21.15 compliant.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.
2. Include ends matching joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.
4. Threaded ends.

E. Flanges: ASME B16.1, Class 125, cast iron.

2.5 PEX TUBE AND FITTINGS (in-wall cavities, concealed space only)

A. PEX Distribution System: ASTM F 877, SDR 9 tubing. System (tubing and fittings) shall be certified by independent third-party certifier. Piping to include aluminum liner. All fittings to be brass with press type connectors.

B. PEX Tube: ASMT F876, ASTM F877, NSF14 and NSF 61, with certification by independent third-party certifier.

C. PEX Fittings: ASMT F1807, ASMT F1960, NSF14, NSF 61, ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

E. PEX piping and fittings shall also be compliant with ASMT F876, ASTM F877, NSF14 and NSF61.

F. This water distribution system shall be installed by a factory-trained installer in accordance with manufacturers installation instructions. Tubing and fittings must be marked with appropriate ASTM designations by manufacturer.

2.6 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.7 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.8 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.9 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description:

a. Pressure Rating: 150 psig at 180 deg F.

b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:

1. Description:

a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

2.10 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.11 WATER METERS

A. Site water meter shall be provided per city/state requirements.

2.12 REDUCED-PRESSURE-PRINCIPLE BACKFLOW PREVENTERS

A. Manufacturers:

1. Ames Fire & Waterworks; a division of Watts Regulator Co.
2. Conbraco Industries, Inc.
3. FEBCO; SPX Valves & Controls.
4. Flomatic Corporation.

5. Watts Water Technologies, Inc.
6. Wilkins; a Zurn company.

B. Description:

1. Standard: AWWA C511.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 10 psig maximum, through middle 1/3 of flow range.
4. Size: Full-pipe-size.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install domestic water piping level and plumb.

G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specif-

ically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

S. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 to NPS 6: Use dielectric flange kits.

3.7 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 WATER METER INSTALLATION

A. Rough-in domestic water piping, and install water meter according to utility company's requirements. This contractor shall coordinate with local city or utility to provide meter as required, and is responsible for all associated costs.

B. Install water meters according to AWWA M6, utility company's requirements.

C. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

D. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

J. Install hangers for vertical PEX piping every 48 inches and/or as indicated in local code whatever is LESS.

K. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if
methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:

1. Soft copper tube without joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 and larger, shall be the following:
1. Push-on-joint, ductile-iron pipe; standard- or compact- pattern push-on-joint fittings; and gasketed joints.

E. Aboveground domestic water piping, NPS 2-1/2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed or soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 3 to NPS 4, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed or soldered joints.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Hose bibbs.
4. Wall & roof hydrants.
5. Drain valves.
6. Water hammer arresters.

B. See Division 22 Section "Domestic Water Piping" for water meters.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data
2. Product certificates
3. Wiring Diagrams
4. Test and Balance report
5. Field quality-control reports.
6. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Ames Co.
    b. Watts Industries, Inc.; Water Products Div.
    c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. MIFAB, Inc.
    b. Watts Industries, Inc.; Water Products Div.
    c. Woodford Manufacturing Company.
    d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Watts Industries, Inc.; Water Products Div.
    b. Zurn Plumbing Products Group; Wilkins Div.
    c. MIFAB

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 or NPS 3/4.
5. Body: Bronze.

6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. Watts Industries, Inc.; Water Products Div.
   b. Zurn Plumbing Products Group; Wilkins Div.
   c. MIFAB

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through or vertical flow.
8. Accessories:

   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
   c. Provide full size hard copper drain line from unit to nearest floor drain.

C. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. Watts Industries, Inc.; Water Products Div.
   b. Zurn Plumbing Products Group; Wilkins Div.
   c. MIFAB

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 HOSE BIBBS

A. Hose Bibbs: As scheduled on drawings.

2.4 WALL & ROOF HYDRANTS

A. Wall hydrants: As scheduled on drawings.

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.6 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Josam Company.
b. MIFAB, Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Wade.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap

device attached to or under backflow preventer. Simple air breaks are not acceptable for this application. Route drain to floor drain.

3. Do not install bypass piping around backflow preventers.

C. Install water hammer arresters in water piping according to PDI-WH 201.

D. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

E. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Intermediate atmospheric-vent backflow preventers.
2. Reduced-pressure-principle backflow preventers.
3. Primary, thermostatic, water mixing valves.

F. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer and/or double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 22 11 19

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

B. See Division 22 Section "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.2 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

C. Water service line must be installed at least 10 feet horizontally from any manhole, catch basin, or any other potential source of contamination (see Minnesota Rules, part 4715.1710, subpart 3).

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS (UNDERGROUND SANITARY)

A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ANSI 21.8, ASTM A 74, Service class.

1. Gaskets: ANSI 21.51, AWWA C151, ASTM C564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS (ABOVE GROUND SANITARY)

A. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: ASTM A 74 Service class, for gasketed joints. Include ASTM C 564 rubber gaskets.

A. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.

1. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
2. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

3. Hubless cast iron pipe and fittings shall be compliant with CISPI standard 301-69T and CSA/CAN 3-B70.

2.4 PVC PIPE AND FITTINGS (VENT PIPING ONLY)

A. PVC unthreaded Pipe: ASTM D 2665, NSF14, CSA-B181.2, CS272, ASTM D 2665, Schedule 40, solid-wall drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the

California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Non-pressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Dallas Specialty & Mfg. Co.
        2) Fernco Inc.
        3) Mission Rubber Company; a division of MCP Industries, Inc.
        4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

    b. Standard: ASTM C 1173.
    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Cascade Waterworks Mfg. Co.
        2) Mission Rubber Company; a division of MCP Industries, Inc.

    b. Standard: ASTM C 1460.
    c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

I. Install PVC vent piping according to ASTM D 2665.

J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

K. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

L. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

M. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.2 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, non-pressure transition couplings.

3.4 VALVE INSTALLATION

A. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

1. Use gate or full-port ball valve for piping NPS 2 and smaller.
2. Use gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Backwater valves are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6and larger: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and larger: 12 feet with 3/4-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and larger: 48 inches with 3/4-inch rod.

J. Install supports for vertical ABS and PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

B. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.

1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
2. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground vent piping shall be any of the following:

1. PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. PVC may not be used if horizontal lengths are greater than 35 feet in total length. No stack can exceed 35 feet in total height unless a code approved expansion and contraction joint is installed at intervals not to exceed 35feet. ABS or PVC may not be used if located above a ceiling that is considered a mechanical plenum.

D. Aboveground, soil waste piping shall be any of the following:

1. Service class, cast-iron iron hub–and-spigot soil pipe and fittings; gaskets; and compression joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

E. Underground, soil, waste, and vent piping shall be any of the following:

1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains/sinks.
3. Miscellaneous sanitary drainage piping specialties.

1.2 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Cleanouts (CO):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sioux Chief #851 provide with coring plug and coring sleeve to protect drain during concrete pour, or a comparable product by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Josam Company; Josam Div.
b. MIFAB.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Sioux Chief Manufacturing Company, Inc.,
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Wade.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil pipe connected piping.
5. Closure: Adjustable countersunk or raised-head, brass.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Floor Cleanouts (FCO):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sioux Chief #852 provide with coring plug and coring sleeve to protect drain during concrete pour, or a comparable product by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Josam Company; Josam Div.
    b. MIFAB.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Light Commercial Operation.
    g. Zurn Plumbing Products Group; Specification Drainage Operation.
    h. Wade.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing, as required to match finished floor level.
5. Body or Ferrule: to match piping.
6. Clamping Device: Not required.
7. Outlet Connection: Spigot or Threaded.
8. Closure: Brass plug with straight threads and gasket, Cast-iron plug or Plastic plug to match body.
9. Adjustable Housing Material: Cast iron or Plastic to match pipe with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy for concrete floor & tile floor. Nickel-bronze, copper alloy with carpet tag (-14) for carpet floors.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser cleanout.

C. Wall Cleanouts (WCO):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Josam #58790 or a comparable product by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Josam Company; Josam Div.
    b. MIFAB
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Watts Drainage Products Inc.
    g. Zurn Plumbing Products Group; Specification Drainage Operation.
    h. Wade.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: as required to match connected piping.
5. Closure: Countersunk or raised-head, plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Floor Drains: As scheduled on drawings.

2.3 TRENCH DRAINS

A. ACO #U 200 heavy duty 8" wide, polyester concrete with sloped channel, ductile iron grate w/integral frame, catch basins w/traps & stainless steel strainers. Assembly to withstand Class E loading (135,000 lb.)

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2: 4-inch- minimum water seal.
    b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.5 Vent Caps:

A. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

B. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install deep-seal traps on floor drains and other waste outlets, if indicated.

H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 31 00 - DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes automatic water softener for domestic water system.

PART 2 - PRODUCTS

2.1 WATER SOFTENER

A. Provided by and complete installation by Contractor.

1. Contractor shall coordinate delivery of equipment to site with vendor, unloading, necessary site storage in acceptable weatherproof, vandal proof location, equipment pad, installation and startup. Advise Engineer of equipment startup and water balance.
2. Coordinate factory startup of all equipment with vendor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water softener on 6-inch-thick concrete base.

B. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible.

C. Anchor water softener and brine tanks to substrate.

D. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

E. Prepare & load resin & salt into tanks.

F. Install piping adjacent to equipment to allow service and maintenance.

G. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Provide shutoff valves on raw-water inlet and soft-water outlet piping.

H. Add water to brine tanks and fill with salt.

I. Provide for flex connections with (2) isolation and (1) bypass valve to connect domestic cold water supply. Provide for brine drain piping routed to trench drain.

3.2 WATER SOFTENER START-UP AND INSTRUCTION IN OPERATION

A. Coordinate with supervising technician from water softener manufacturer to review completed installation, start system in operation and acquaint Owner's representatives with operation and care of equipment. Provide statements to Architect signed by Owner's representatives stating that they have received proper instruction and understand all operating and maintenance procedures.

3.3 WATER TEST

A. After system has been started and adjusted, water softener manufacturer's representative shall test un-softened and softened water for hardness levels, sulfur content, bacterial content, etc. and submit a certified report to Architect for Owner's records.

END OF SECTION 22 31 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data for each type of plumbing fixture, including trim, fittings, accessories, appliances, appurtenances, equipment, and supports.
2. Documentation indicating flow and water consumption requirements.

PART 2 - PRODUCTS

2.1 PER FIXTURE SCHEDULE LISTED ON DRAWINGS

A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" and "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.

B. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

PART 3 - EXECUTION

3.1 INSTALLATIONS

A. Install isolation valves on each cold & hot water feed serving fixtures. Valves shall be installed directly above the fixture, in an accessible location.

B. Install fitting insulation kits on fixtures for people with disabilities.

C. Install fixtures with flanges and gasket seals.

D. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

E. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

F. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated. Provide floor mounted carriers for all wall mount lavatories, urinal, and water closets.

G. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

H. Fasten wall-mounted fittings to reinforcement built into walls.

I. Fasten counter-mounting plumbing fixtures to casework.

J. Secure supplies to supports or substrate within pipe space behind fixture.

K. Set shower receptors and mop basins in leveling bed of cement grout.

L. Install individual supply inlets, supply stops, supply risers, and tubular brass traps with cleanouts at fixture.

M. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes unless otherwise indicated.

N. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.

O. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.

P. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.

Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

R. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

S. Install piping connections between plumbing fixtures and piping systems and plumbing equipment. Install insulation on supplies and drains of fixtures for people with disabilities.

T. Coordinate w/Electrical Contractor for 120V electrical circuit to Plumbing Contractor supplied control transformer at all automatic flush valve and faucet. Coordinate low voltage control cabling from transformer to valve/faucet with Electrical Contractor. All wiring, controls to be installed above ceiling with low voltage cabling routed in wall cavity to below fixture.

END OF SECTION 22 40 00

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hangers and Supports for Plumbing Piping Equipment:

1. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

a. Design supports for multiple pipes capable of supporting combined weight of supported systems, and system contents.
b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
c. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 SLEEVES AND SLEEVE SEALS

A. Galvanized-Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. PVC Pipe: ASTM D 1785, Schedule 40.

C. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

D. Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

E. Stack-Seal Fitting: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2.4 ESCUTCHEONS AND FLOOR PLATES

A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

C. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

2.5 PRESSURE GAGES AND TEST PLUGS

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed Open-front, pressure relief; cast aluminum; 4-1/2-inch nominal diameter.
3. Movement: Mechanical, with link to pressure element and connection to pointer.
4. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
5. Pointer: Dark-colored metal.
6. Window: Plastic.
7. Ring: Metal.
8. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Test Plug: Corrosion-resistant brass or stainless-steel body with two self-sealing rubber core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping. Minimum pressure and temperature rating of 500 psig at 200 deg F.

2.6 HANGERS AND SUPPORTS FOR HVAC

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

C. Fastener Systems:

1. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches thick.
2. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
3. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

D. Miscellaneous Materials:

1. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
2. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

    a. Properties: Nonstaining, noncorrosive, and nongaseous.
    b. Design Mix: 4000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATIONS

A. Install piping free of sags and bends.

B. Install fittings for changes in direction and branch connections.

C. Sleeves:

1. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
2. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

a. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

3. Install stack-sleeve fittings in new slabs as slabs are constructed.
4. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
5. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078446 "Penetration Firestopping."

D. Sleeve-Seal-System Installation:

1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
2. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

E. Escutcheons & Floor Plates:

1. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
2. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
3. Install floor plates for piping penetrations of equipment-room floors.
4. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

F. Install unions at final connection to each piece of equipment.

G. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.

H. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

3.2 HANGERS AND SUPPORTS

A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.

B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.

C. Install powder-actuated fasteners and mechanical-expansion anchors in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.

D. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
4. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

3.3 GENERAL EQUIPMENT INSTALLATIONS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Mix and install grout for pump and other equipment base plates, and anchors. Place grout, completely filling equipment bases.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Coordination:

1. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

a. Motor controllers.
b. Torque, speed, and horsepower requirements of the load.
c. Ratings and characteristics of supply circuit and required control sequence.
d. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTOR CHARACTERISTICS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

C. Polyhase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.

a. Service Factor: 1.15.

2. Multispeed Motors: Variable torque.

a. For motors with 2:1 speed ratio, consequent pole, single winding.
b. For motors with other than 2:1 speed ratio, separate winding for each speed.

3. Rotor: Random-wound, squirrel cage.
4. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

5. Temperature Rise: Match insulation rating.
6. Insulation: Class F.
7. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

8. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Polyphase Motors with Additional Requirements

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

E. Single Phase Motors:

1. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

F. VFD Driven Motors

1. Equip with AEGIS Bearing Protection Ring

PART 3 - EXECUTION (Not Used)

END OF SECTION 23 05 13

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

C. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

C. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, or comparable product by one of the following:

1. Presealed Systems.

C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves or Galvanized-steel wall sleeves.
b. Piping NPS 6 and Larger: Cast-iron wall sleeves or Galvanized-steel wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves, PVC-pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings, or Molded-PVC sleeves.

b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves, PVC-pipe sleeves, or Stack-sleeve fittings.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or PVC-pipe sleeves in non-fire rated walls.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 05 17

SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plate or rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
f. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated or rough-brass finish.
g. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
h. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated or rough-brass finish.
i. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 05 18

SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flowmeters.
5. Thermal-energy meters.

B. Related Sections:

1. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers gages and flowmeters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer gage and flowmeter, signed by product manufacturer.

D. Operation and Maintenance Data: For flowmeters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum 9 inches.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Window: Glass Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

B. Case: Die-cast aluminum, 7 inches long.

C. Tube: Red or blue reading, organic filled, with magnifying lens.

D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Metal, for installation in mounting bracket and of length to suit installation.

H. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.

I. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. KOBOLD Instruments, Inc.
3. Marsh Bellofram.
4. Trerice, H. O. Co.
5. Weiss Instruments, Inc.
6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

F. Pointer: Red metal.

G. Window: Glass.

H. Ring: Metal.

I. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.

3. Marsh Bellofram.
4. Palmer - Wahl Instruments Inc.
5. Trerice, H. O. Co.
6. Weiss Instruments, Inc.
7. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

F. Pointer: Red metal.

G. Window: Glass.

H. Ring: Metal.

I. Connector: Back union type.

J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.5 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Ernst Gage Co.
3. Eugene Ernst Products Co.
4. Marsh Bellofram.
5. Palmer - Wahl Instruments Inc.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

C. Case: Dry type, stainless steel with 5-inch diameter.

D. Element: Bimetal coil.

E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

F. Pointer: Red.

G. Window: Glass.

H. Ring: Stainless steel.

I. Connector: Adjustable angle type.

J. Stem: Metal, for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.6 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Palmer - Wahl Instruments Inc.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.7 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Palmer - Wahl Instruments Inc.
8. Trerice, H. O. Co.
9. Weiss Instruments, Inc.
10. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.

2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Remote-Mounting, Dial-Type Pressure Gages: ASME B40.100, indicating-dial type.

1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

D. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Sisco Manufacturing Co.
3. Trerice, H. O. Co.
4. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
3. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic heat exchanger.

B. Provide the following temperature ranges for thermometers:

1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions
2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions 30 to 240 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry-case-type pressure gages at chilled-water inlets and outlets of chillers.

C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install remote-mounting pressure gages on panel.

F. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

G. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

H. Install test plugs in tees in piping.

3.4 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Bronze gate valves.
8. Iron gate valves.
9. Bronze globe valves.
10. Iron globe valves.
11. Chainwheels.

.

1.2 QUALITY ASSURANCE

A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. All valves to be certified lead free.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height above 6 ft AFF.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.

PRODUCT DATA SHEET 2 - Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.

g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Milwaukee Valve Company.

k. NIBCO INC.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. American Valve, Inc.

b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements)::

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. NIBCO INC.

2. Description:

    a. Standard: MSS SP-71, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Clear or full waterway.
    d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    e. Ends: Flanged.
    f. Trim: Bronze.
    g. Gasket: Asbestos free.
    h. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Crane Co.; Crane Valve Group; Stockham Division.
    d. Hammond Valve.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-71, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Clear or full waterway.
    d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    e. Ends: Flanged.
    f. Trim: Bronze.
    g. Gasket: Asbestos free.
    h. Closure Control: Factory-installed, exterior lever and weight.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements)::

    a. American Valve, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Division.

e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.

e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Crane Co.; Crane Valve Group; Stockham Division.
    d. Flo Fab Inc.
    e. Hammond Valve.
    f. Kitz Corporation.
    g. Milwaukee Valve Company.
    h. NIBCO INC.
    i. Powell Valves.
    j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-70, Type I.
    b. CWP Rating: 200 psig.
    c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: Bronze.
    f. Disc: Solid wedge.
    g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements)::

    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Crane Co.; Crane Valve Group; Stockham Division.
    d. Flo Fab Inc.
    e. Hammond Valve.
    f. Kitz Corporation.
    g. Milwaukee Valve Company.
    h. NIBCO INC.
    i. Powell Valves.
    j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-70, Type I.
    b. CWP Rating: 200 psig
    c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: Bronze.
    f. Disc: Solid wedge.
    g. Packing and Gasket: Asbestos free.

2.10 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.

1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, or butterfly valves.
2. Throttling Service: Ball, or butterfly valves.
3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.

c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 HOT AND CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and brass: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bonze and brass trim.
3. Bronze Swing Check Valves: bronze.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.

END OF SECTION 23 05 23

SECTION 23 05 25 – ROOF CURBS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Qualitative requirements for roof curbs for equipment mounting and piping penetrations.

PART 2 - PRODUCTS

2.1 Roof Curbs

A. Provided by Mechanical Contractor

1. Curbs shall be seismically designed and stamped by Professional Engineer.
2. All curbs shall be all welded, galvanized steel, insulated w/1" thick fiberglass R5.0 or greater, and minimum 16" high.

2.2 Pipe Portals

A. Provided by Mechanical Contractor.

B. Manufacturer: Roofing Products and Systems (RPS)

C. Curb shall be covered with a thermoplastic cover, fastening screws, graduated step boots with stainless steel adjustable clamps.

D. Boots: Neoprene, stepped configuration with stepped sizes corresponding to pipe external dimensions.

E. Band Clamps: Stainless steel, secured by a stainless-steel worm screw and rack arrangement.

PART 3 - EXECUTION

3.1 Installation of Roof Curbs & Equipment Rails

A. Provided by Mechanical Contractor and installed by General Contractor.

B. Roof curbs and equipment rails shall be mounted with top dead level, properly anchored to the deck. Curbs to roof structure with approved seismic anchors.

3.2 Installation of Pipe Portals

A. Provided by Mechanical Contractor and installed by General Contractor.

B. Provide pipe portals for pipe that passes through roof, located where required and where shown on Drawings.

C. If portal locations are not shown on drawing, coordinate piping arrangement to route as many pipes as practical through individual portals to keep quantity of portals to a minimum.

D. Follow manufacturer's recommendations and instructions for arrangement, installation, etc.

END OF SECTION 23 05 25

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

1.2 REFERENCES

A. American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)

1. ANSI/ASME B31.1, Power Piping, (SI Edition).

B. American Society for Testing and Materials (ASTM)

1. ASTM A125, Specification for Steel Springs, Helical, Heat-Treated.
2. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
3. ASTM A563, Specification for Carbon and Alloy Steel Nuts.

C. Factory Mutual (FM)

D. Health Canada / Workplace Hazardous Materials Information System (WHMIS).

1. Materials Safety Data Sheets (MSDS).

E. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

1. MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
2. ANSI/MSS SP-69, Pipe Hangers and Supports - Selection and Application.
3. MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
2. Base maximum load ratings on allowable stresses prescribed by MSS SP58 or ASME B31.1.
3. Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
4. Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
5. Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP58.

B. Performance Requirements

1. Design supports, platforms, catwalks, hangers, to withstand seismic events for location as per the National Building Code

1.4 SUBMITTALS

A. Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

B. Shop drawings: submit drawings stamped and signed for approval by Owner's Representative.

C. Submit shop drawings and product data for following items:

1. Bases, hangers and supports.
2. Connections to equipment and structure.
3. Structural assemblies.

D. Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

1. Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
2. Instructions: submit manufacturer's installation instructions.

a. Owner's Representative will make available 1 copy of systems supplier's installation instructions.

E. Closeout Submittals:

1. Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals

1.5 QUALITY ASSURANCE

A. Health and Safety:

1. Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, handling and unloading:

1. Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
2. Deliver, store and handle materials in accordance with manufacturer's written instructions.

B. Waste Management and Disposal:

1. Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

A. Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58 and SP-89.

2.2 PIPE HANGERS

A. Finishes:

1. Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
2. Use electro-plating galvanizing process or hot dipped galvanizing process.
3. Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

B. Upper attachment structural: Suspension from lower flange of I-Beam.

1. Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

a. Rod: 9 mm UL listed, 13 mm FM approved.

2. Cold piping NPS 2 1/2 or greater, hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed, FM approved where required to MSS-SP58 and MSS-SP69.

C. Upper attachment structural: Suspension from upper flange of I-Beam.

1. Cold piping NPS 2 maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved where required to MSS SP69.
2. Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed, FM approved where required.

D. Upper attachment to concrete.

1. Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
2. Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved where required to MSS SP-69.

E. Shop and field-fabricated assemblies.

1. Trapeze hanger assemblies: MSS SP-89.
2. Steel brackets: MSS SP-89.
3. Sway braces for seismic restraint systems: to MSS SP-89.

F. Hanger rods: threaded rod material to MSS SP-58.

1. Ensure that hanger rods are subject to tensile loading only.
2. Provide linkages where lateral or axial movement of pipework is anticipated.
3. Do not use 22 mm or 28 mm rod.

G. Pipe attachments: material to MSS SP-58.

1. Attachments for steel piping: carbon steel galvanized.
2. Attachments for copper piping: copper plated black steel.
3. Use insulation saddles for hot pipework.
4. Oversize pipe hangers and supports for insulated pipes.

H. Adjustable clevis: material to MSS SP-69, UL listed FM approved, where required clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

1. Ensure "U" has hole in bottom for rivetting to insulation shields.

I. Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-69.

J. U-bolts: carbon steel to MSS SP-69 with 2 nuts at each end to ASTM A563.

1. Finishes for steel pipework: galvanized.
2. Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated or epoxy coated.

K. Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-69.

2.3 RISER CLAMPS

A. Steel or cast iron pipe: galvanized black carbon steel to MSS SP-58, type 42, UL listed FM approved where required.

B. Copper pipe: carbon steel copper plated to MSS SP-58, type 42.

C. Bolts: to ASTM A307.

D. Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

A. Insulated cold piping:

1. 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

B. Insulated hot piping:

1. Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP-69.

2.5 CONSTANT SUPPORT SPRING HANGERS

A. Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

B. Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

C. Provide upper and lower factory set travel stops.

D. Provide load adjustment scale for field adjustments.

E. Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

F. Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

A. Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

B. Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

C. Variable spring hanger to be complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

D. Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.7 EQUIPMENT SUPPORTS

A. Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

A. Provide templates to ensure accurate location of anchor bolts.

2.9 HOUSE-KEEPING PADS

A. For base-mounted equipment: Concrete, at least 100 mm high, 50 mm larger all around than equipment, and with chamfered edges.

B. Concrete: to Section 03 30 00 - Cast-in-place Concrete by Division 3.

2.10 OTHER EQUIPMENT SUPPORTS

A. From structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.

B. Submit structural calculations with shop drawings.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

A. Install in accordance with:

1. Manufacturer's instructions and recommendations.

B. Vibration Control Devices:

1. Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.

C. Clamps on riser piping:

1. Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
2. Bolt-tightening torques to be to industry standards.
3. Steel pipes: Install below coupling or shear lugs welded to pipe.
4. Cast iron pipes: Install below joint.

D. Clevis plates:

1. Attach to concrete with 4 minimum concrete inserts, one at each corner.

E. Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

F. Use approved constant support type hangers where:

1. Vertical movement of pipework is 13 mm or more,
2. Transfer of load to adjacent hangers or connected equipment is not permitted.

G. Use variable support spring hangers where:

1. Transfer of load to adjacent piping or to connected equipment is not critical.
2. Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

A. Plumbing piping: most stringent requirements of Canadian Plumbing Code

B. Fire protection: to applicable fire code.

C. Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

D. Copper piping: up to NPS 1/2: every 1.5 m.

E. Hydronic, steam, condensate, rigid, and flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

Maximum Pipe Size: NPS	Maximum Spacing: Steel	Maximum Spacing: Cop-per
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m

Maximum Pipe Size: NPS	Maximum Spacing: Steel	Maximum Spacing: Copper
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

F. Within 300 mm of each elbow.

G. Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

A. Install hanger so that rod is vertical under operating conditions.

B. Adjust hangers to equalize load.

C. Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members, comprised of angel iron or c-channel.

3.5 HORIZONTAL MOVEMENT

A. Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

B. Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

A. Adjust hangers and supports:

1. Ensure that rod is vertical under operating conditions.
2. Equalize loads.

B. Adjustable clevis:

1. Tighten hanger load nut securely to ensure proper hanger performance.
2. Tighten upper nut after adjustment.

C. C-clamps:

1. Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

D. Beam clamps:

1. Hammer jaw firmly against underside of beam.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each product indicated.
2. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. All seismic roof curbs shall include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 115 MPH.
2. Building Classification Category as Defined in the IBC: III.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D
2. Building Seismic Design Category: C
3. Assigned Seismic Risk Category as Defined in the IBC: III.

a. Component Importance Factor: 1.0. To be determined from ASCE 07-10 section 13.1.1 for each component type
b. Component Response Modification Factor: 2.5. To be determine from ASCE 07-10 Table 13.6-1 for each component type

c. Component Amplification Factor: 2.5. To be determine from ASCE 07-10 Table 13.6-1 for each component type

4. Design Spectral Response Acceleration at Short Periods (0.2 Second): 43.3%g.
5. Design Spectral Response Acceleration at 1-Second Period: 23.1%g.

D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2.2 VIBRATION ISOLATORS

A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

B. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

C. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

G. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

H. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

2.3 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

C. Restraint Cables: ASTM A 603 galvanized- steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

PART 3 - EXECUTION

3.1 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.4 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment: Fan coils, duct, hydronic piping

1. Equipment Location
2. Base Type: Cables.
3. Component Importance Factor: 1.25.
4. Component Response Modification Factor: 2.5.
5. Component Amplification Factor: 2.5.

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Identify all installed mechanical distribution piping, mechanical equipment and components.
2. Cast-in-place concrete.

C. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 01 Section "Special Procedures."
3. Division 09 Section "Painting" for identification painting.

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
4. Refer to Division 23 Section "Common Results for HVAC" for codes and standards, and other general requirements.

B. ANSI/ASME –American National Standards Institute/Society of Mechanical Engineers:

1. ASNI/ASME A 13.1 Scheme for the identification of piping systems

1.3 SUBMITTALS

A. Submit under provisions of Division 23 Section "Common Results for HVAC, Review of Materials" and Division 01 Section "General Requirements."

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Submit valve database as per Part 3.05 -Stenciling and Identification, D.3 - Valve Tags.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. W. H. Brady, Seton or Almatek products.

B. No substitutions.

2.2 MATERIALS

A. Color coding: ANSI/ASME A13.1 unless specified otherwise.

B. Plastic nameplates: laminated two-layer plastic with engraved black letters on light, contrasting background color.

C. Plastic tags: laminated three-layer (double-sided) plastic with engraved black letters on light, contrasting background color. Tag size at least 1-1/2 inch (38 mm) diameter.

D. Plastic pipe markers: factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

1. Special gases shall be identified using markers with yellow background and black letters, direction arrow, and full chemical names and symbols.

E. Plastic-tape pipe markers: flexible, vinyl-film tape with pressure-sensitive adhesive backing and printed markings.

F. Equipment tags: Metal tags, Almetek TH-9A with 500-series consisting of Almetek industries 9-character aluminum holder #TH-9A with 500-series characters, black on yellow background. Format is 2 characters for building # (15), space, 2 or 3 characters for equipment type (AC, AHU, etc.), space, three-digit equipment number (001, etc.). These tags can be ordered in parts and site-assembled, or pre-assembled from the factory. Attachment is by a pair of rivets, screws, or bolts onto the equipment to be identified; for water meters and similar equipment installed in piping, a pair of chains can be used for attachment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive of identification materials.

B. Prepare surfaces in accordance with Division 09 Section "Painting" for stencil painting.

3.2 INSTALLATION

A. Plastic nameplates: install with corrosion-resistant mechanical fasteners, or adhesive.

B. Plastic tags: install with corrosion-resistant chain.

C. Plastic pipe markers: install in accordance with manufacturer's instructions.

D. Plastic-tape pipe markers: install completely around pipe in accordance with manufacturer's instructions.

E. Underground plastic pipe markers: install 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

F. Equipment tags: Install with corrosion-resistant mechanical fasteners.

3.3 IDENTIFICATION SCHEDULE

A. Equipment: identify air-handling units, pumps, heat-transfer equipment, tanks, boilers, blowers, and water-treatment devices, etc (see mechanical and plumbing schedules) with equipment tags per Section 2.2H. Small devices, such as VAV boxes and VFD's, may be identified with plastic tags.

B. Controls: identify control panels and major control components outside of panels with plastic nameplates.

C. Valves: identify valves in main and branch piping with tags.

D. Piping: identify piping, concealed or exposed, with stenciled painting. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not more than 20 feet (6 m) apart on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

E. Ductwork: identify ductwork with stenciled painting. Identify as to air-handling unit number, and area served. Locate identification at air-handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

3.4 VALVE DATA BASE

A. Provide specified valve database.

3.5 IDENTIFICATION

A. Label each piece of new and existing equipment including pumps, fans, tanks, etc., with the equipment tags scheduled on the drawings and per Part 2 above.

1. Stencil each duct leaving the mechanical room indicating fan unit, area(s), direction of flow, or room(s) served.
2. Stencil each duct branch leaving an air shaft at each floor with fan number, and identify it as a supply, exhaust, or return duct, and indicate direction of air flow.

B. Post a framed and typewritten schedule of all stencils, pipe markers, and valve tags, used, with identification, shall be framed and posted in the mechanical equipment room.

C. Identify all pipes with specified markers.

1. Install markers every 10 feet (3 m) on mains, at all branch take-offs and adjacent to valves and cocks.
2. Apply to all exposed pipes, pipes behind removable tile ceiling, pipes in concealed but accessible locations, such as behind access panels and at least once in each room.
3. Install pipe marker using pressure sensitive adhesive in accordance with the manufacturer's directions. The marker shall completely cover the circumference of the pipe and overlap itself.

D. Valve Tags: Provide numbered tags for main valves, branch valves, zone valves, shut-off valves, and balancing valves installed under this Contract, constructed of #18 gauge (1.02 mm) brass, circular, 1 ¼ inches (31.7 mm) in diameter, and with numbers cut in and blackened so as to be plainly discernible. Fasten tags to valve with brass links.

1. Valve numbers not required for valves obviously serving equipment such as air handler coils, reheat coil valves, and miscellaneous drains.
2. On the as-built drawings, indicate the location and number of each tagged valve.
3. Provide a computer file database in a form agreeable to the Owner, describing the valve, number, location , type of service normally “open” or “closed”, specific duty of each tagged valve, and manufacturer and model number.

E. Warning Sign at Fume Exhaust Plenums: Place warning sign on each fume exhaust plenum access - "WARNING. HAZARDOUS ATMOSPHERE INSIDE. USE BREATHING APPARATUS" when breaching containment.

F. Place warning signs on all machines driven by electric motors which are controlled by fully automatic starters. See Section 3320, Article 7, Subchapter 7, General Industry Safety Orders, Title 8, California Code of Regulations.

G. Fire dampers and fire smoke dampers: at each fire damper or fire smoke damper access panel, label "FIRE DAMPER" or “FIRE SMOKE DAMPER” in minimum 1 inch (25 mm)

high letters. Fire smoke dampers shall be provided with tags to identify each fire smoke dampers with 2 lines as follows: the first line "FSD-NUMBER SEQUENCES-BLDG NUMBER" (e.g. FSD-001-15). The second line "ZONE FIRE ALARM-zone" that activates the damper (e.g. ZONE L1-03). Tags shall be engraved plastic with white letters on red background. Provide chart to Owner for approval.

H. Wherever charts, Shop Drawings, etc. Refer to specific room numbers, use room numbers that will be provided by the university rather than the room numbers indicated on the Drawings.

I. Pipe Label Color Schedule:

1. Chilled Water

   a. Background Color: Green.
   b. Letter Color: White

2. Hot Water

   a. Background Color: Green.
   b. Letter Color: White.

3. Steam

   a. Background Color: White.
   b. Letter Color: Red.

J. Ceiling Label:

1. Provide small colored decal on ceilings, directly underneath valves. Coordinate decal size, shape, & color with Owner.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. All air & water systems

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

A. Certified TAB reports.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. All balancing shall be compliant with MN IMC 1346.309.

F. All startup and testing shall be compliant with MN IMC 107.2.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Certified TAB reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" Section 233116 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. ASHRAE 62.1-2004 requires that ventilation systems be balanced according to ASHRAE 111, SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," or equivalent at least to extent necessary to verify compliance with the standard.

B. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or

NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

D. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

E. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet flows with required fan flows.

B. Create schematic diagrams of each air systems' sections showing measurement locations.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
3. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

K. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicated airflows within specified tolerances.

L. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.1 GENERAL PROCEDURES FOR BALANCING WATER SYSTEMS

A. Prepare test reports for both pumps and equipment. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet flows with required pump flows.

B. Create schematic diagrams of each system showing measurement locations.

C. For variable volume systems, develop a plan to simulate diversity.

D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check valves for proper position to achieve desired flow.

G. Adjust valves to deliver total indicated flows within the maximum allowable pump speed listed by manufacturer.

3.2 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.

5. Nameplate and measured voltage, across each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

1. Measure flow through bypass.

3.3 PROCEDURES FOR FAN Coil UNITS

A. Verify proper rotation of fans.

B. Measure entering and leaving-air temperatures in both heating and cooling modes

C. Verify hydronic flow for both heating & cooling modes

D. Verify flow and temperature control valve operation.

3.4 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

3.5 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.6 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of cur rent calibration.

B. Schedule:

1. Submit preliminary test and balance report to Engineer at least one week prior to Owner training for installed equipment.
2. Submit certified test and balance report(s) to be bound into or included with delivery of Owner's Operation and Maintenance manuals.

C. Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Field test and start-up reports prepared by system and equipment installers.

D. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fan and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan/pump drive settings including settings and percentage of maximum speed
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.

h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

3.7 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 – DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials.
2. Fire-rated insulation systems.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Tapes.
7. Fasteners.
8. Corner angles.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.
2. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. CertainTeed Corp.; Commercial Board.
    b. Fibrex Insulations Inc.; FBX.
    c. Johns Manville; 800 Series Spin-Glas.
    d. Knauf Insulation; Insulation Board.
    e. Manson Insulation Inc.; AK Board.
    f. Owens Corning; Fiberglas 700 Series.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Aeroflex USA, Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
3. All fitting must be must be factory fabricated, not field fabricated fitting allowed.

2.2 PIPES, TUBES, AND FITTINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

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

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile

Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

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

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.
6. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 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. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 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, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) 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, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.7 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal or closed seal.

1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

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, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) 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, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
   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, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) 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- (0.41-mm-) thick, galvanized-steel, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

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-(0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1) GEMCO.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. C & F Wire.

2.8 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), 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.

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 ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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 (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

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

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLTION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be

insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end

of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Clean all ductwork as recommend by manufacturer.
2. Install mitered sections of pipe insulation.
3. 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.
4. Install insulation to flanges as specified for flange insulation application.

3.6 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 (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) 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 metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

3.7 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect/Engineer, 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 duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 INSULATION SCHEDULE, GENERAL

A. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Factory-insulated access panels and doors.

B. All exterior ductwork shall be insulated with 2" rigid insulation, and wrapped with full-perimeter EDPM roofing membrane liner, to create a weatherproof seal. Roofing membrane liner color selection by Architect.

Table 1: Typical HVAC Equipment, Piping and Duct Insulation Applications

HVAC Systems	Insulation Types (1)	Density (lbs./cu.Ft.)	Insulation Thickness	Vapor Barrier Requirements (2)	Jacket Types (3)
Supply air ducts (concealed interior)	GF, CG	1.5	1-1/2 inch	yes	FSK (4)
Supply air ducts (exposed interior)	GF, CG	3.0	1-1/2 inch	yes	FSK (4)
Return air ducts (interior)		-	-	-	-
Outside Air air ducts	GF, CG	3.0	1-1/2 inch	yes	FSK (4)
Exhaust ducts (all within 15'0" of exterior)	GF, CG	1.5	1-1/2 inch	yes	FSK

(1) Key to Insulation Materials:

GF = glass or mineral fiber

CG = cellular glass

FE = flexible elastomeric foam, closed cell

PF = closed cell phenolic foam

CS = calcium silicate

HTGF = high temperature glass fiber

(2) Key to Vapor Barrier Requirements

yes = required

none = not required

SJ = continuous sealed joint required

(3) Key to Jacket Requirements:

AP = All purpose foil, scrim, kraft paper jacket (white)

FSK = Foil, scrim, kraft paper jacket with foil finish

PVC = PVC jacket

AL = Aluminum jacket

SS = Stainless steel jacket

GC = Canvas or glass cloth

(4) Glass cloth jacket and rigid board insulation required in mechanical room and exposed ductwork within 8 feet of floor.

END OF SECTION 23 07 13

SECTION 23 07 16 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:

1. Chillers.
2. Heat exchangers.
3. Chilled-water pumps.
4. Heating, hot-water pumps.
5. Expansion/compression tanks.
6. Air separators.
7. Thermal storage tanks.
8. Piping system filtration unit housings.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. 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; Foamglas.

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. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials 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. K-Flex USA; Insul-Sheet and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. 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.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

I. 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. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
    b. Johns Manville; HTB 26 Spin-Glas.
    c. Roxul Inc.; Roxul RW.

J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation factory-applied ASJ, 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.; CertaPro Commercial Board.

b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

K. 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, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

a. Fibrex Insulations Inc.; FBX.Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
b. Rock Wool; Delta Board.
c. Roxul Inc.; RHT and RockBoard.
d. Thermafiber, Inc.; Thermafiber Industrial Felt.
e. <Insert manufacturer's name; product name or designation>.

L. 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-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

M. 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.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

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. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

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. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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 Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric 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.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. ASJ Adhesive, 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. 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 Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

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

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
   b. Eagle Bridges - Marathon Industries; 501.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.

d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
4. Service Temperature Range: 0 to plus 180 deg. F.
5. Color: White.

2.6 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.

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.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

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.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 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. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M 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.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M 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.

7. 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.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. in a Leno weave, for equipment.

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

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. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. 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 Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White
4. Factory-fabricated tank heads and tank side panels.

D. Metal 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.

c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209 Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricated fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

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. Polyguard Products, Inc.; Alumaguard 60.

F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

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 Film.

G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

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 560 Vapor Retarder Film.

H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

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 Film and Saran 560

2.11 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. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
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. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 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. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. 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. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    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 for Indoor Applications: 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: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: 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 560 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.

2.12 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.

   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.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   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.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. 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.

    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 Perforated Base Insul-Hangers.
        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.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized 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.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy

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

2.13 CORNER ANGLES

A. PVC Corner Angles: 30 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 EXAMINATION

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

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils) thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg. F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Cat carbon steel operating at a service temperature between 32 and 300 deg. F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. 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.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

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.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.050 inch] thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. 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.

C. 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 manufacturers 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.

D. 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.

E. Where PVDC jackets are indicated, install as follows:

1. 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. 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.
2. 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.

3.6 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: 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.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 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 that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.

D. Chilled-water pump insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

E. Heating-hot-water pump insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

F. Chilled-water expansion/compression tank insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches thick.
2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

G. Heating-hot-water expansion/compression tank insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches thick.
2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

H. Chilled-water air-separator insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

I. Heating-hot-water air-separator insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Pipe and Tank: 2 inches thick.

J. Piping system filter-housing insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Pipe and Tank: 2 inches thick.

K. Buffer tank insulation shall be one of the following, with outdoor field-applied jacket:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.

3.9 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.

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

1. None.

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

1. None.

3.10 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, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

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

1. Aluminum, Smooth with 4-by-1-Inch Box Ribs: 0.032 inch thick.

END OF SECTION 23 07 16

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Chilled-water piping, indoors and outdoors.
3. Heating hot-water piping, indoors and outdoors.
4. Steam and steam condensate piping, indoors and outdoors.
5. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

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

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. 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; Foamglas.

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: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

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. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. 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.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

I. 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-Degree Pipe Insulation.
    d. Manson Insulation Inc.; Alley-K.
    e. Owens Corning; Fiberglas Pipe Insulation.

J. 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.

K. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

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. Ramco Insulation, Inc.; Super-Stik.

L. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

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. Ramco Insulation, Inc.; Thermokote V.

M. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric 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.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. ASJ Adhesive, 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. 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 Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

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

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    b. Eagle Bridges - Marathon Industries; 501.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    b. Eagle Bridges - Marathon Industries; 570.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
    b. Eagle Bridges - Marathon Industries; 405.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.

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.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

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.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 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. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz. /sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz. /sq. yd.

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. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. 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 Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. 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.

D. Metal 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: [3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. 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 Products, Inc.; Insulrap No Torch 125.

F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with [white] [stucco-embossed] aluminum-foil facing.

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. Polyguard Products, Inc.; Alumaguard 60.

2.10 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. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
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. ABI, Ideal Tape Division; 491 AWF FSK.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    c. Compac Corporation; 110 and 111.
    d. Venture Tape; 1525 CW NT, 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. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. 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. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    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.

2.11 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

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.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and

300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- 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, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches 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.

3.4 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 Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

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. 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 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

A. Seal longitudinal seams and end joints with the 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 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. 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.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with the 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.

D. 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.

3.10 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to 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.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 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.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

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

B. Chilled Water, above 40 Deg F:

1. NPS 8 and Smaller: Insulation shall be one of the following:

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

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 1-1/4" and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.

2. NPS 1-1/2" and Larger: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

D. Steam and Steam Condensate, 350 Deg F and Below:

1. All Pipe Sizes: Insulation shall be Preformed Mineral Fiber with ASJ jacket – 3 inches thick.

E. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be Flexible Elastomeric: 1 inch thick.

F. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water:

1. All Pipe Sizes: Insulation shall be one of the following:

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

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. All Pipe Sizes: Insulation shall be one of the following:

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

C. Steam and Steam Condensate, 350 Deg F and Below (located inside steam manhole/vault):

1. All Pipe Sizes: Insulation shall be calcium silicate: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be Flexible Elastomeric: 2 inches thick.

3.15 UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill mechanical and waterproof protection insulation, for belowground piping, as indicated on drawings.

B. Underground buried steam & condensate piping insulation shall be factory-applied by Thermacor, Inc.

3.16 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. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. None.

3.17 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. Piping, Concealed:

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

D. Piping, Exposed:

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried piping insulation material per manufacturers requirements.

END OF SECTION 23 07 19

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Contractor shall provide complete DDC Schneider Ecostructure system from Comfort Systems USA. Contact Mike Fisher at mike.fisher@comfortsystemsusa.com or 502-363-2654 for proposals.

C. System license, software and graphics, and all hardware shall become property of the Owner.

D. Products furnished but not installed under this Section.

1. Control Valves.
2. Flow Switches.
3. Temperature Sensor Wells and Sockets.
4. Terminal Unit Controller (ASC).

E. All sleeping room & private office thermostats indicated on construction documents shall have local control & display.

1. All sleeping room & private office stats shall be combination thermostat/humidistat type, but no programming for humidity control required. Any humidity control needed will be performed under future contract.

F. No public thermostats indicated on construction documents shall have local control & display. Setpoint adjustment & monitoring shall be performed through the BMS only.

1. All public stats shall be combination thermostat/humidistat type, with programming for humidity control required.

G. All HVAC-related CAT-rated cabling shall be BLUE in color, to differentiate between other low-voltage cabling being installed throughout building.

H. Temperature Controls Contractor shall provide & install all variable frequency drives and air- & water-side differential pressure sensors.

1.2 DEFINITIONS

A. BACnet: Building Automation Control Network as defined in ASHRAE 135.

B. BMS: Building Management System.

C. DDC: Direct digital control.

D. FC Bus: Field Controller Bus (Sub-network).

E. I/O: Input/output.

F. Internetwork: A two-tiered topology where building controllers and OWS operate as high speed network, and application specific controllers, custom application controllers al party controllers operate as peers on a number of sub-networks with the building co acting as a router to connect the high speed network and sub-networks.

G. LAN: Local Area Network.

H. MS/TP: Master slave/token passing.

I. PC: Personal computer.

J. PID: Proportional plus integral plus derivative.

K. RTD: Resistance temperature detector.

1.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F.
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.

d. Space Temperature: Plus or minus 1 deg F.
e. Ducted Air Temperature: Plus or minus 1 deg F.
f. Outside Air Temperature: Plus or minus 2 deg F.
g. Dew Point Temperature: Plus or minus 3 deg F.
h. Temperature Differential: Plus or minus 0.25 deg F.
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
l. Airflow (Terminal): Plus or minus 10 percent of full scale.
m. Air Pressure (Space): Plus or minus 0.01-inch wg.
n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
o. Carbon Monoxide: Plus or minus 5 percent of reading.
p. Carbon Dioxide: Plus or minus 50 ppm.
q. Electrical: Plus or minus 5 percent of reading.

1.4 SEQUENCE OF OPERATION

A. General

1. Provide fully implemented application and custom software, controllers, network id and controls devices necessary to accomplish the control sequence in conformance with the control diagrams.
2. Points to be alarmed and/or monitored shall be as described in the sequences r indicated on drawings.
3. All set points shall be adjustable.
4. In the event of a power failure all controls shall go to their fail open (FO), fail close or fail last (FL) positions as indicated on drawings.
5. The BMS shall have a sequential restart program for the restart of all equipment (fans, AHU's etc.) upon restoration of power after a loss of power.
6. Provide alarm monitoring of chilled water supply & return water temperatures, building hot water supply and return water temperatures. All alarm monitoring shall be via separate BMS controller for diversity.

1.5 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufa and model number. Include technical data for interface equipment, control transducers/transmitters, sensors, actuators, valves, relays/switches, control panel operator interface equipment.
2. Control System Software: Include technical data for operating system software, or interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of c manufacturer, model number, and product data. Include written description of seq of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including flow characteristics.
7. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing data conductors and wiring between operator workstation and contra locations.

8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
9. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list including identification number, display units, set points, alert set points, point type (AO, AI, DO, DI), manufacturer and model number.

C. Data Communications Protocol Certificates: Certify that each proposed DDC component complies with ASHRAE 135.

D. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

F. Field quality-control test reports as described in Part 3 of this specification.

G. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. All work, materials and equipment shall comply with the rules and regulations of all cod, ordinances of the local, state and federal authorities. As a minimum the installation shall with the current editions of the following codes:

1. National Electrical Code (NEC)
2. Uniform Building Code (UBC)
3. Uniform Mechanical Code (UMC)

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with ASHRAE 135-2004 for DDC system components.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.8 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Division 26 Section "Common Work Results for Electrical" to achieve compatibility of communication interfaces.

D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

E. Coordinate equipment with Division 26 Section "Common Work Results for Electrical" to achieve compatibility with motor starters and annunciation devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Manufacturers:

1. System Manufacturer and Installer:

a. Schneider Ecostructure provided and installed by Comfort Systems USA of Louisville, Kentucky.

2. Miscellaneous Devices:

a. Belimo Air Controls (USA), Inc.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and program control and monitor mechanical and electrical systems. Software and hardware for operator workstation that permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 DDC EQUIPMENT

A. Operator Workstation: Contractor shall utilize existing operator's workstation.

B. Diagnostic Terminal Unit (Provide at least one, maximum of two): Portable notebook-style, PC- based microcomputer terminal capable of accessing system data by connecting to network with minimum configuration as follows:

1. System: With two integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet) integrated audio, bios, and hardware monitoring.
2. Processor: Intel Xeon E3-1220 v6ore 3.0 Ghx, 3.5Ghz Turbo
3. Graphics: Video adapter, minimum 1024 x 768 pixels, 64-MB video memory.
4. Monitor: 17 inches (430 mm), LCD color.
5. Keyboard: QWERTY 105 keys in ergonomic shape.
6. Hard-Disk Drive: 8.0 GB.
7. CD-ROM ReadNVrite Drive: 48x24x48.
8. Pointing Device: Touch pad or other internal device.

C. Communication

1. Control products, communication media, connectors, repeaters, hubs, and routs comprise a network. Controllers and operator interfaces communication conform to ANSI/ASHRAE Standard 135-2004, BACnet communication protocol.
2. Each controller shall have a communication port for connection to an operator internetwork.
3. Controllers on the internetwork shall be provided with a 56,000 baud modem to allow for remote operator interface allowing communication with any and all control this network as described below.
4. Internetwork operator interface and value passing shall be transparent to the internal architecture.

    a. An operator interface connected to a controller shall allow the operator to interface with each network controller as if directly connected. Controller information such as data, status, reports, system software and customer programs shall be viewable and editable from each internetwork controller.
    b. Inputs, outputs and control variables used to integrate control strategies multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified system operations. An authorized operator shall be able to edit cross-controller links by typing a standard object address.

5. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices and wiring. Expansion shall not operator interface hardware addition or software revisions.

D. Controller Software

1. Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.
2. System Security

    a. User access shall be secured using individual security passwords and user name.
    b. Passwords shall restrict the user to the objects, applications and system as assigned by the system manager.

c. User log on/log off attempts shall be recorded.
d. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

3. Scheduling. Provide the capability to schedule each object or group of objet system. Each schedule shall consist of the following:

   a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start stop and night economizer. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust and stop times for each member.
   b. Exception Schedules. Provide the ability for the operator to designate any of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
   c. Holiday Schedules. Provide the capability for the operator to define a special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

4. System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.
5. Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
6. Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
7. Alarm Reporting. The operator shall be able to determine the action to be taken in event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged even log, generate custom messages and display graphics.
8. Remote Communication. The system shall have the ability to dial out in the event of alarm.
9. Demand Limiting.

   a. The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted building power meter or from a watt transducer or current transformer attached to the building feeder lines.
   b. The demand limiting program shall predict the probable power demand such that action can be taken to prevent exceeding the demand limit; action will be to reduce loads in a predetermined manner. When demand prediction indicates the demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
   c. Demand reduction shall be accomplished by the following means:

      1) Reset air handling unit supply temperature set point up by 2°F.

2) Reset space temperature set points up by 2°F.
3) De-energize equipment based upon priority.

d. Demand limiting parameters, frequency of calculations, time intervals and relevant variables shall be based on the means by which the local power company computes demand changes.
e. Provide demand limiting prediction and control for any individual meter by the system or for the total of any combination of meters.
f. Provide the means for an operator to make the following changes online:

1) Addition and deletion of loads controlled.
2) Changes in demand intervals.
3) Changes in demand limit for meter(s).
4) Maximum shutoff time for equipment.
5) Minimum shutoff time for equipment.
6) Select rotational or sequential shedding and restoring.
7) Shed/restore priority.

g. Provide the following information and reports, to be available on an hour and monthly basis:

1) Total electric consumption.
2) Peak demand.
3) Date and time of peak demand.
4) Daily peak demand.

10. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.
11. Sequencing. Provide application software based upon the sequence of operation specified to properly sequence chillers, boilers and pumps.
12. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time analog value that is used to position and output or stage a series of output controlled variable, set point, and PID gains shall be user-selectable.
13. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order, in which equipment, or groups of equipment) is started, along with the time delay between starts, shall be user selectable.
14. Energy Calculations.

a. Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., gpm) to be accumulated and converted to energy usage data.
b. Provide and algorithm that calculates a sliding window average (e.g., average). The algorithm shall be flexible to allow window intervals to be specified (e.g., 15 minutes, 30 minutes, 60 minutes).
c. Provide and algorithm that calculates a fixed window average. A digit signal will define the start of the window period (e.g., signal from utility meter) to synchronize the fixed window average with that used by the utility.

15. Anti-Short Cycling. All binary output objects shall be protected from short cycling feature shall allow minimum on-time and off-time to be selected.
16. On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct or reverse-acting and incorporate an adjustable differential.
17. Run Time Totalization. Provide software to totalize run times for all binary input. A high run time alarm shall be assigned, if required, by the operator.

E. Building Controllers

1. General. Provide the minimum number of building controllers as indicated drawings to achieve the performance specified in the Part 1 Article on "System Performance". Each of these panels shall meet the following requirements:

    a. The Building Management System shall be composed of one or more independent, stand alone, microprocessor based building controllers to manage the global strategies described in the system software section.
    b. The building controller shall have sufficient memory to support its operating system, database and programming requirements.
    c. Data shall be shared between networked building controllers.
    d. The operating system of the building controller shall manage the input and communication signals to allow distributed controllers to share real and object information and allow for central monitoring and alarms.
    e. Controllers that perform scheduling shall have a real time clock.
    f. The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

        1) Assume a predetermined failure mode.
        2) Generate an alarm notification.

2. Communication

    a. The building controller shall communicate with other building controller operator workstations through a high speed network utilizing BACnet II custom application controllers, application specific controllers and third equipment controllers through a sub-network utilizing BACnet MS/TP.
    b. The building controller shall provide a service communication for connection to a portable operator's terminal.

3. Environment. Controller hardware shall be suitable for the anticipated ambient condition.

    a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -40°F to 40°C .
    b. Controllers used in conditioned space shall be mounted in dust-proof enclosure and shall be rated for operation at 32°F to 120°F (0°C to 50°C).

4. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system password shall be available to prevent unauthorized use of the keypad and

display manufacturer does not provide this keypad and display, provide a second portable operator terminal.

5. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips termination card connected by a ribbon cable.
6. Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
7. Immunity to power and noise. Controller shall be able to operate at 90% to 110% 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 keyed radios up to 5W at 3 ft (1m).

F. Custom Application Controllers

1. General. Provide an adequate number of Custom Application Controllers (CAC) achieve the performance specified in the Part 1 Article on "System Performance". Each of these panels shall meet the following requirements

   a. The custom application controller shall have sufficient memory to support its operating system, database and programming requirements.
   b. Data shall be shared between networked custom application controllers.
   c. The operating system of the controller shall manage the input and communication signals to allow distributed controllers to share real and object information and allow central monitoring and alarms.
   d. Controllers that perform scheduling shall have a real time clock.
   e. The custom application controller shall continually check the status of its pro and memory circuits. If an abnormal operation is detected, the controller shall:

      1) Assume a predetermined failure mode.
      2) Generate an alarm notification

2. Communication

   a. The custom application controller shall communicate with other custom application controllers, application specific controllers and third party controllers through bus utilizing BACnet MSITP.
   b. The custom application controller shall provide a service communication for connection to a portable operator's terminal.

3. Environment. Controller hardware shall be suitable for the anticipated conditions.

   a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°C to 65°C).
   b. Controllers used in conditioned space shall be mounted in dust-proof an and shall be rated for operation at 32°F to 120°F (0°C to 50°C).

4. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad

and display manufacturer does not provide this keypad and display, provide a second portable operator terminal.

5. Serviceability. Provide diagnostic LEDs for power, communication, and process wiring connections shall be made to field-removable, modular terminal strips termination card connected by a ribbon cable.
6. Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
7. Immunity to power and noise. Controller shall be able to operate at 90% to 110% 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 keyed radios up to 5W at 3 ft (1 m).

G. Application Specific Controllers

1. General. Application specific controllers (ASCs) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable but are customized for operation within the confines of the equipment they are designated to serve.

    a. Each ASC shall be capable of stand alone operation and shall continue to provide control functions without being connected to the network.
    b. Each ASC will contain sufficient I/O capacity to control the target system.

2. Communication

    a. The application specific controller shall communicate with other custom application controllers, application specific controllers and third party controllers through bus utilizing BACnet MS/TP.
    b. The application specific controller shall provide a service communication for connection to a portable operator's terminal.

3. Environment. The hardware shall be suitable for the anticipated ambient condition.

    a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°F to 150°F.
    b. Controllers used in conditioned space shall be mounted in dust-proof enclosure and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
5. Memory. The application specific controller shall use nonvolatile memory and all BIOS and programming information in the event of a power loss.
6. Immunity to power and noise. Controller shall be able to operate at 90% to 110% 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 from keyed radios up to 5 W at 3 ft.
7. Transformer. Power supply for the ASC must be rated at a minimum of 125% power consumption and shall be of the fused or current limiting type.

H. Input/Output Interface

1. Hardwired inputs and outputs may tie into the system through building, application, or application specific controllers.
2. All input points and output points shall be protected such that shorting of the point itself, to another point, or to ground will cause no damage to the controller. All output points shall be protected from voltage up to 24V of any duration, such that with this voltage will cause no damage to the controller.
3. Binary inputs shall allow the monitoring of On/Off signals from remote device; binary inputs shall provide a wetting current of at least 12mA to be compatible commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
4. Pulse accumulation input objects. This type of object shall conform to requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
5. Analog inputs shall allow the monitoring of low voltage (0 to 10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
6. Binary outputs shall provide On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application control shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
7. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (Auto/Manual) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
8. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for three-point floating type electronic actuators without feedback. Use of three-point devices shall be limited to zone control and terminal unit control application terminal units, duct mounted heating coils, zone dampers, radiation, etc). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. Input/Output points shall be the universal type, i.e., controller input or output may be designated (in software) as either binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.
10. System Object Capacity. The system size shall be expandable to at least (20) times the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require hardware additions or software revisions in order to expand the system.

I. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protect ion; limit connected loads to 80 percent of rated capacity. DC power supply shall match output and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 overload for at least 3 seconds without failure.

J. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 PANELS

A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.

B. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

C. Provide ON/OFF power switch with overcurrent protection for control power sources local panel.

2.5 ELECTRONIC SENSORS AND TRANSMITTERS

A. Manufacturers:

1. Room Temperature Sensors (TT)

a. Schneider
b. Automation Components, Inc. (ACI)
c. Honeywell, Inc.
d. Johnson Controls, Inc.
e. Siemens Controls, Inc.

2. Temperature Elements/Transmitters (TT)

a. Automation Components, Inc. (ACI)
b. Honeywell, Inc.
c. HyCal Sensing Products.
d. Johnson Controls, Inc.
e. Rosemount.
f. Siemens Controls, Inc.

g. Vaisala, Inc.
h. Yokogawa.

3. Humidity (Moisture) Transmitters (HT)

a. Automation Components, Inc. (ACI)
b. General Eastern Instruments, Inc.
c. HyCal Sensing Products.
d. Johnson Controls, Inc.
e. Siemens Controls, Inc.
f. Vaisala, Inc.

4. Temperature/Moisture Transmitters (TT/HT)

a. General Eastern Instruments, Inc.
b. HyCal Sensing Products.
c. Vaisala, Inc.

5. Dew Point Temperature/Moisture Transmitters (TT/HT)

a. General Eastern Instruments, Inc.
b. HyCal Sensing Products.
c. Vaisala, Inc.

6. Flow (FT), Pressure (PT) and Pressure Differential (PDT) Transmitters

a. Air Monitor Corporation.
b. Ashcroft.
c. Dwyer Instruments, Inc.
d. Foxboro.
e. Honeywell, Inc.
f. Rosemount.
g. Setra Systems, Inc.
h. Yokogawa.

7. Pressure Differential Indicating Switches (PDIS)

a. Dwyer Instruments, Inc.

B. Description: Vibration and corrosion resistant; for wall, immersion, or duct mount required.

C. Thermistor Room Temperature Sensors (TT)

1. Accuracy: Plus or minus 0.36 deg F (0.2 deg C) at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Resistance: 10,000 Ohms.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: N/A
b. Set-Point Indication: N/A
c. Digital temperature display: N/A

D. RTDs and Transmitters (Air and Water, TT):

1. Accuracy: Plus or minus 1.0% of calibrated span.
2. Temperature Element: 100 Ohm or 1000 Ohm Platinum Class A RTD.
3. Wire: Twisted, shielded-pair cable.
4. Output Signal: 4 to 20 mA, linear.
5. Temperature Range: Room/Duct 40°F to 110°F, Outdoor Air -20°F to 140°F, Water to 220°F or as noted on drawings.
6. NIST traceable.
7. Insertion Elements in Ducts: Single point, minimum 8 inches (200 mm) long; use not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
8. Averaging Elements in Ducts: Minimum of 60 inches/10 square feet of duct free area; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
9. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
10. Room Transmitter Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment Concealed.
    b. Set-Point Indication: Concealed.
    c. LCD temperature display.

11. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
12. Room Security Sensors: Stainless-steel cover plate with insulated back and screws.
13. Basis of design product: Subject to compliance with requirements, provide ACI A/TT 100 or comparable product from manufacturers listed above.

E. Moisture/Humidity Transmitter (HT).

1. Accuracy: 2 percent full range.
2. Range: 0 to 100 percent relative humidity.
3. Drift: Shall not exceed 1% of full scale per year.
4. Output Signal: 4 to 20 mA, linear.
5. MIST traceable.
6. Room Sensor Cover Construction: Manufacturers standard locking covers.
7. Outside-Air Sensor: Suitable for operation at outdoor temperatures of minus 22 to 185 deg F with mounting enclosure.
8. Duct Sensors: Suitable for operations at temperatures of 30°F to 140°F with guard and mounting plate
9. Basis of design product: Subject to compliance with requirements, provide HMDNV60 or comparable product from manufacturers listed above.

F. Temperature

1. Accuracy: 2 percent full range (RH) and t 1.0% of calibrated span (temperature).
2. Range: 0 to 100 percent relative humidity, -4°F to 176°F dry bulb temperature.
3. Drift: Shall not exceed 1% of full scale per year.
4. Output Signals (2): 4 to 20 mA, linear for dry bulb temperature and relative humidity.
5. NIST traceable.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.

7. Outside-Air Sensor: Suitable for operation at outdoor temperatures of minus 22 to 185 deg F with mounting enclosure.
8. Duct Sensors: Suitable for operations at temperatures of 30°F to 140°F with guard and mounting plate
9. Basis of design product: Subject to compliance with requirements, provide HMD/W60 or comparable product from manufacturers listed above.

G. Dew Point Temperature /Moisture Transmitter (TT/HT)

1. Accuracy: 2 percent full range (I ± 1.0% of calibrated span (temperature).
2. Range: 0 to 100 percent relative humidity, -4°F to 176°F dew point temperature and 40°F to 176°F dry bulb temperature.
3. Drift: Shall not exceed 1% of full scale per year.
4. Output Signals (2): 4 to 20 mA, linear for dry bulb temperature and dew point temperature/relative humidity.
5. Display: LED of both dry bulb and dew point temperatures.
6. NIST traceable.
7. Outside-Air Sensor: Suitable for operation at outdoor temperatures of minus 22 to 185 deg F with mounting enclosure.
8. Duct Sensors: Suitable for operations at temperatures of 30°F to 140°F with guard and mounting plate
9. Basis of design product: Subject to compliance with requirements, provide Vaisala 100 or comparable product from manufacturers listed above.

H. Flow (FT), Pressure (PT) and Pressure Differential (PDT) Transmitters:

1. Air - Flow (FT) and Pressure Differential (PDT) Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.

    a. Accuracy: ±1.0% FS including effects of linearity, hysteresis and repeatability.
    b. Output: 4 to 20 mA for linear or square root.
    c. Pressure Differential Range: As noted on drawings or as required for flow for FT.
    d. Overpressure Limit: 10-psig.
    e. NIST traceable.
    f. Basis of design product: Subject to compliance with requirements, provide Model 264 or comparable product from manufacturers listed above.

2. Air - Pressure Differential Indicating Transmitter (PDIT): Non-directional sensor with suitable range for expected input, and temperature compensated.

    a. Accuracy: ±1.0% FS including effects of linearity, hysteresis and repeatability.
    b. Output: 4 to 20 mA for linear or square root.
    c. Display: LCD.
    d. Pressure Differential Range: As noted on drawings or as required for flow for FT.
    e. Overpressure Limit: 10-psig.
    f. NIST traceable.
    g. Basis of design product: Subject to compliance with requirements, provide Model 267 or comparable product from manufacturers listed above.

3. Air - Pressure Sensors (PE): Shielded static pressure probes shall be provided for room pressure differential and duct static pressure monitoring.

    a. Probe shall have multiply sensing ports, pressure impulse suppression chamber air flow shielding and takeoff fitting contained in an aluminum casing or stainless steel if noted on drawings, with brushed finish on exposed surfaces.
    b. Room sensor shall sense static pressure in the proximity of the sensor with the actual pressure value while being subjected to a maximum airflow 1000 FPM from a 360° radial source.
    c. Probe shall be self-draining where room washdown is required.
    d. Basis of design product: Subject to compliance with requirements, provide air Monitor corporation S.A.P. or comparable product from manufacturer above.

4. Water — Flow Transmitter (FT), Pressure (PT) and Pressure Differential Transmitters: All stainless-steel wetted parts, suitable for service indicated, LED of pressure and status switch.

    a. Accuracy: ±0.15% of span including effects of linearity, hysteresis repeatability.
    b. Rangeability: 100 to 1
    c. Output: 4 to 20 mA for linear or square root.
    d. Pressure range: As noted on drawings or as required for flow element for F
    e. Minimum 150-psig operating pressure and tested to 300-psig.
    f. Manifold: Integral manifold with "flangeless valves". Block and bleed for DI five valve for FT and PDT.
    g. NIST traceable.
    h. Basis of design product: Subject to compliance with requirements, Rosemount 3051CD (FT & PDT), Rosemount 3051T (PT) or comparable from manufacturers listed above.

5. Air - Pressure Differential Indicting Switch (PDIS): Pressure indicating gage phototransistor circuits and two DPDT relay for high and low limit indication.

    a. Accuracy: ±2.0% FS.
    b. Set Point Adjustment: High and low set points adjustable from front of gage.
    c. Outputs: Each set point has two Form C relays (DPDT).
    d. Pressure Differential Range: As noted on drawings.
    e. Pressure Limits: -20" Hg to 25 psig.
    f. NIST traceable.
    g. Basis of design product: Subject to compliance with requirements, provide Series A 3000 or comparable product from manufacturers listed above.

2.6 STATUS SENSORS

A. Status Inputs for Fans (PDS): Differential-pressure switch with pilot-duty rating and with adjustable range suitable for maximum dead head pressure of fan.

B. Status Inputs for Pumps (PDS): Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range suitable for maximum dead head pressure of pump, across pump.

C. Current Switches (IS): AC current switch shall be the self-powered, combination split-core current transformer type with either normally open (NO) or normally closed (NC) solid state output, adjustable trip set point and green/red LED to monitor status of switch. Units shall be suitable to continuously monitor currents up to 250 Amps. Comply with ISA 50.00.0 suitable for 175 percent of rated motor current.

D. Current Transmitter (IT): AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale internal zero and span adjustment and ±1% full-scale accuracy at 500 ohm maximum burden. Comply with ISA 50.00.01 and suitable for 175 percent of rated motor current.

E. Electronic Valve/Damper Position Indicator (ZI): Visual scale indicating percent of travel to 10-V dc, feedback signal.

F. Valve/Damper Position Switch (ZS); Mechanically activated electrical switch (SPDT) providing accurate and reliable indication that valve/damper is fully open or fully closed.

G. Water-Flow Switches (FS): Bellows-actuated mercury or snap-acting type with pilot-duty stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

H. Pressure-Electric Switches (XS$^{P"}$**)**: Shall be metal or neoprene diaphragm actuated, pressure rated 0-175 kPa (0-25 psig), with calibrated scale setpoint range of 14-125 kPa minimum. UL listed. Provide one- or two-stage switch action SPDT, DPST, or DP required by application. Electrically rated for pilot duty service (125 VA minimum) motor control. Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified and have a permanent indicating gauge on each pneumatic signal line to PE switches.

2.7 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. H2scan.
2. INTEC Controls, Inc.
3. MSA Canada Inc.
4. QEL/Quatrosense Environmental Limited.
5. Sensidyne, Inc.

B. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrate to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

C. Hydrogen Sensor and Transmitter: Suitable over a temperature range of minus 60 to deg F (-20 to 40 deg C) and calibrated for 0.4 to 5.0 percent hydrogen by volume and 1- percent lower flammability limit, 4- to 20-mA output and two programmable 60 VDC/1A SPDT relays with both normally open and normally closed contacts; for wall or ceiling mounting.

2.8 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

    a. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. damper.
    e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24 or 120-V ac as determined by BMS provider.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
12. Run Time: 12 seconds open, 5 seconds closed.

2.9 CONTROL VALVES

A. Manufacturers:

1. Asco.
2. Baumann Valves.
3. Fisher Controls, Inc.
4. Johnson Controls, Inc.
5. Magnatrol Valve Corporation.
6. Siemens Controls, Inc.
7. Spence Engineering Co., Inc.
8. Warren Controls.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity re-packable under pressure.
2. NPS 2-1/2 (ON 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: Maximum pressure drop at design flow rate shall be as indicated in Contra Schedule on drawings, otherwise as follows:

    a. Two Position: Line size.
    b. Two-Way Modulating: Five (5) psig or twice the pressure drop through the heat exchanger, whichever is more.
    c. Three-Way Modulating: Five (5) psig or the pressure drop through the coil exchanger, whichever is more.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristic way valves shall have linear characteristics. Rangeability shall be 50 to 1.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall minimum close-off pressure rating of 150 percent of total system (pump) head way valves and 100 percent of pressure differential across valve or 100 percent system (pump) head.

D. Steam system globe valves shall have the following characteristics:

1. NPS 2 (ON 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity re-packable under pressure.
2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

4. Sizing: For pressure drop based on the following services:

    a. Two Position: Less than 10 percent of inlet pressure.
    b. Modulating 15-psig (103-kPa) Steam: 80 percent of inlet steam pressure.
    c. Modulating 16- to 50-psig (110- to 350-kPa) Steam]: 50 percent of inlet pressure.
    d. Modulating More Than 50-psig (350-kPa) Steam: As indicated.

5. Flow Characteristics: Modified linear characteristics with rangeability of 30 to 1.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

E. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug.
2. Disc Type: Elastomer-coated ductile iron.
3. Sizing: Pressure drop as scheduled or indicated above at design flow rate.

F. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

G. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Thermostatic Operator. Liquid-filled, integral or remote sensor with integral adjustable dial.

2.10 DAMPERS

A. All dampers shall be provided by mechanical contractor or air handling unit manufacturer. BMS provider shall coordinate with mechanical contractor and air handling unit manufacturer on installation by BMS provider of actuators and other control devices.

2.11 WIRING AND RACEWAYS

A. General: Provide copper wiring, plenum cable, and raceways as specified in the appropriate sections of Division 26.

B. All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

2.12 FIBER OPTIC CABLE SYSTEM

A. Optical cable: Optical cables shall be duplex 900 in tight-buffer construction designed fior intra-building environments. The sheath shall be UL listed OFNP in accordance with NEC 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/1.

B. Connectors: All optical fibers shall be field-terminated with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment location. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

C. The contractor shall examine the drawings and specifications for other parts of the head room or space conditions appear inadequate — or if any discrepancies occur

between the plans and the contractor's work and the plans and the work of others — the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any change: work covered by this specification made necessary by the failure or neglect of the contractor's report such discrepancies shall be made by — and at the expense of — this contractor.

D. The contractor shall verify that power supply is available to control units and workstation.

E. The contractor shall verify that duct-, pipe-, and equipment-mounted devices are before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches (1220 mm) above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

G. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

H. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Divison 26 shall provide 120V power at electrical panels for application specific con (ASC) and miscellaneous low voltage power requirements. Temperature Controls Contractor shall be responsible for all electricals from aforementioned electrical panels to their equipment/components.

B. Install raceways, boxes, and cabinets according to Division 26 Section "Common Work Results for Electrical."

C. Install building wire and cable according to Division 26 Section "Common Work Results for Electrical."

D. Install signal and communication cable according to Division 27 Section "Structured Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side, protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 CONTROLLERS

A. Provide a separate controller for each AHU or other HVAC system. Points used for control loop reset, such as outside air or space temperature, are exempt form this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.

1. Future use of spare capacity shall required providing the field device, field wiring, point data-base definition, and custom software. No additional controller boards or modules shall be required to implement use of these spare points.

3.5 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% available memory free for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator in without the use of a written point index. Use naming convention indicated on control and in sequences.

C. Software Programming

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Imbed control program sufficient comment statements to clearly describe each section program. The comment statements shall reflect the language used in the sequel operation. Use the appropriate technique based on the following programming types:

a. Text based:

1) Must provide actions for all possible situations.
2) Must be modular and structured.
3) Must be commented.

b. Graphic based:

1) Must provide actions for all possible situations.
2) Must be documented.

c. Parameter based:

1) Must provide actions for all possible situations.
2) Must be documented.

D. Operator Interface

1. Standard graphics — Provide graphics for all mechanical systems and floor plan building. This includes each chilled water system, hot water system, chiller, air handler, and all terminal equipment. Point information on the graphic displays dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
2. Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
3. The contractor shall provide all the labor necessary to install, initialize, start of troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, third-party software installation and integration required for successful operation operator interface.

3.6 WARNING LABELS

A. Permanent warning labels shall be affixed to all equipment that can be automatically started from the DDC system.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows: "CAUTION - This equipment is operating automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing."

B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows: "CAUTION - This equipment is fed form more than one power source with separate disconnects. Disconnect all power sources before servicing."

3.7 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled end within 2 in of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument served.

C. Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplate.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.
3. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
4. Test each system for compliance with sequence of operation.
5. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.9 ADJUSTING

A. Calibrating and Adjusting:

1. Test equipment shall be NIST traceable.
2. Calibrate instruments.
3. Make three-point calibration test for both linearity and accuracy for each analog instrument.
4. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
5. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.
e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

6. Flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

7. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

8. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

9. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
10. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
11. Provide diagnostic and test instruments for calibration and adjustment of system.
12. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.10 SITE ACCEPTANCE TEST

A. General:

1. This test shall demonstrate that the work specified in this specification is in accordance with the Contract Documents without fault or defect of any kind.
2. Upon completion of the work covered by this specification, and after systems are set and adjusted, conduct performance tests of various systems and devices shall be carried out under supervision of Owner or Owner's Representative

acceptance of control system shall be arranged for purpose of demonstrating satisfactory functional and accurate operating characteristics as well as adjustment.

3. During this period, setting of instrumentation and equipment shall be check and sufficient measurements taken to ensure that conditions are correct, and capacities are adequate to meet specified requirements. Provide competent personnel to conduct System will not be considered complete until tests have been concluded to satisfaction of Owner and other parties having jurisdiction. In event of faults or defects, tests must be repeated after faults and defects are corrected. Tests shall be performed in presence of the Owner or Owner's Representative. Tests shall be performed under as near conditions as possible.
4. Furnish instruments, test equipment and personnel required for tests. Owner will provide electrical power and water for tests.
5. Control system shall be tested in 'step by step' manner following approved procedures. Tests shall include but not necessarily be limited to the following:

    a. Control system shall be exercised to demonstrate that requirements of monitor and control have been met and that control system has been adjusted and will operate as specified.
    b. Contractor shall demonstrate that points can be interrogated and commanded as specified.
    c. Contractor shall demonstrate that control system software programs respective building, custom application and application specific controllers and function as specified.

6. High speed network and sub-networks verification shall be performed with existing OWS and application programs operating under normal control system loading conditions.
7. Testing shall be conducted on control system exclusive of other usage. Simultaneous use of control system for development, debug, or other purpose shall not be during testing.
8. Precautions must be taken to ensure that no equipment shall be damaged during testing.
9. Records of tests including nameplate data for identification shall be retained for three copies in operating instructions. Records shall be on permanent record mat fit 8-1/2" x 11" binders.
10. Testing specified represents minimum requirements. Specific tests shall be required by applicable codes and jurisdictional authorities.
11. After completion of Acceptance Test, tests found to be unacceptable shall be recorded on field report that will be given promptly to contractor.
12. Field report items then found to be unacceptable shall require contractor to take further action to make them acceptable.
13. Reasonable time will be allowed for contractor to refine, replace, restore, repair or otherwise correct unacceptable work; however, contractor shall expedite such when field report items are corrected, the contractor shall request another test in writing.
14. Should additional expense occur to the Owner, due to repeated testing, such expense shall be deductible by Owner from final payment due contractor, not as a permit because contractor's failure to correct the work properly has made additional testing necessary. In the event of such deducted amount, Owner will furnish evidence expenses to contractor.

15. Responsibility for delays caused by equipment damaged or otherwise unavailable testing rests with contractor.
16. Satisfactory completion of Site Acceptance Test shall be requirement for final control system acceptance.
17. Contractor shall notify Owner and the Testing and Balancing Contractor when testing has been successfully completed.

B. Operators Work Station (Existing)

1. Contractor shall demonstrate capability of control system to perform data collection presentation, operator interface, supervisory control, communications and other functions specified.
2. Contractor shall demonstrate that (existing) OWS configuration meets specified requirements for CPU, memory, disk storage, and expansion.
3. Contractor shall demonstrate operation of (existing) OWS terminals.
4. BAS contractor shall demonstrate that (existing) OWS software and database work specified is complete. (Existing) OWS software and database shall be installed a line throughout Acceptance Test.
5. Contractor shall demonstrate that (existing) OWS software configuration work spec is complete. This shall include:

    a. Database.
    b. Graphics.
    c. Reports.
    d. Point groups.
    e. Trends.
    f. Alarms.
    g. Historian.
    h. Menu.

6. Contractor shall maintain (existing) OWS password access security.
7. Contractor shall demonstrate that (existing) OWS meets specified requirements. The intent is also to demonstrate capabilities of (existing) OWS as in manufacturer's published product literature. Testing shall include but not ne be limited to:

    a. Communications with building, custom application and application controllers.

        1) Report alarm and return to normal conditions.
        2) Report digital change of state.
        3) Report analog change of value.
        4) Downloading of data such as new setpoints.
        5) Report loss of building, custom application and application controllers communications.

    b. Supervisory control functions.
    c. Alarm display and acknowledgment.
    d. Create new color graphic display

        1) Use of symbol library.
        2) Display change of value/status for analog/digital point.

3) Flashing when point goes into alarm.

e. Create new report.
f. Monitor DDC control loop.
g. Trending.

1) Create new trend group.
2) Trend multiple analog points on the same display in real-time.
3) Trend historical data.

h. Log on and log off procedures.
i. User interface including:

1) Response to keyboard input errors.
2) Function keys.
3) Mouse (if applicable).
4) Trackball (if applicable).

j. Operation of (existing) OWS local area network.

C. Building, Custom Application and Application Specific Controllers

1. Contractor shall demonstrate capability of control system to accurately monitor control field sensors and actuators specified. Tests shall be conducted to verify end accuracy and repeatability of control system in response to field inputs to custom application and application specific controllers, including accurate display of status and values and annunciation of alarms. Tests shall also be conducted to verify that control system accurately responds to commands to generate output specified. Monitoring and control functions specified shall be tested.
2. Contractor shall demonstrate that each type of distributed processing units (building, custom application and application specific controllers) meets specified requirements for monitoring, control, interface to field sensors and actuators, software, communications networked operation, and stand-alone operation. Intent is also to demonstrate capabilities of building, custom application and application specific controllers as stated in manufacturer's published literature. Testing of building, custom application and application specific controllers shall include but not necessarily be limited to:

a. Communications with OWS.

1) Report alarm and return to normal conditions.
2) Report digital change of state.
3) Report analog change of value.
4) Execution of supervisory control commands.
5) Downloading of data such as new setpoints.

b. Controller to controller communications.

1) Data from sensor connected to one building, custom application or application specific controller is available at another building, application or application specific controller on network.

2) Alarm from sensor connected to one building, custom application or application specific controller initiates program or sequence in another building, custom application or application specific controller.
3) Communications on each type of building, custom application or application specific controllers network and sub-network.

c. Building, custom application and application specific controllers programming local terminal.

1) Change setpoint.
2) Change alarm limit.

d. Automatic restart of building, custom application and application controllers after power failure.
e. Battery backup of building, custom application and application specific controllers memory.
f. Trending and data logging.
g. Add new point using alphanumeric descriptive point name and demonstrate point is operational in the control system.
h. Automatic scaling of analog data.
i. Real-time clock and time schedule functions.
j. Stand-alone control without communication with Host computer or other building custom application and application specific controllers.
k. Manual override of automatic control functions.

3. Contractor shall demonstrate that control loops have been properly tuned and are performing control functions as specified in this section and as described on the Instrument & Control Diagram drawings. For each control loop, contractor must demonstrate the following, as a minimum:

a. Control system can maintain control loop setpoint within specified tolerance continuous period of no less than 30 minutes. Demonstration shall include minimum, hard copy listing control loop associated point values trended at maximum 30 (thirty) second intervals. All software tuning parameters, time and filters utilized to meet this demonstration shall be submitted to Owner as a hardcopy of the tuning parameters baseline.
b. When offset to setpoint is introduced, control system can achieve control setpoint within five minutes after change has been made. Demonstration shall include, as a minimum, hard copy listing control loop associated point trended at maximum 15 (fifteen) second intervals. All software tuning parameters, time delays and filters utilized to meet this demonstration shall be submitted to Owner as a hardcopy of the tuning parameters baseline.

3.11 DEMONSTRATION

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

END OF SECTION 23 09 00

SECTION 23 09 93 – SEQUENCES OF OPERATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sequence of operation for mechanical systems and equipment.

1. Strictly adhere to specified sequences for respective equipment and systems.
2. Furnish all devices required to accomplish respective operating sequences, whether specified or not.
3. Devices not furnished by respective equipment manufacturer shall be supplied by TCC.

B. Control Devices: Electric.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (CONTROLS SEQUENCE)

3.1 HEAT PUMP UNITS

A. Provide for automatic control of all 2- pipe hydronic heat pump units.

B. Provide digital interface between heat pump controllers and the Building Energy Management System. Heat pump control with building automation system interface shall provide remote control and sensing of fan and valve operation, and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. All sleeping room & private office thermostats indicated on construction documents shall have local control & display. Temperature setpoints, monitoring, & fan operation shall be at the individual thermostat.

D. No public thermostats indicated on construction documents shall have local control & display. Temperature setpoints and time schedules shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. Fans shall operate continuously during Occupied and cycle to offset zone heat gains/losses in Unoccupied periods.

E. Control valves shall open/close to offset space heat gains/losses.

F. Control valves shall be electric-operated, 2-way, 2-position type.

3.2 HP-263 & HP-364 HEAT PUMP UNITS

A. Provide for automatic control of 2- pipe hydronic heat pump units.

B. Provide digital interface between heat pump controllers and the Building Energy Management System. Heat pump control with building automation system interface shall provide remote control and sensing of fan and valve operation, and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. No public thermostats indicated on construction documents shall have local control & display. Temperature setpoints and time schedules shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. Fans shall operate continuously during Occupied and cycle to offset zone heat gains/losses in Unoccupied periods.

D. Control valves shall open/close to offset space heat gains/losses.

E. Control valves shall be electric-operated, 2-way, 2-position type.

F. Freeze Protection: A low limit temperature sensor shall be located on the upstream side of the heat pump coil. If a mixed air temperature of 45°F (adj.) or less is detected, then the outside air M.O. damper shall fully close and the return air M.O. damper shall fully open, and the heat pump unit shall be disabled. Upon correction of the problem, the system must be manually reset. The freeze protection wire shall be serpentine across the entire face of the water coil approximately every four inches. Provide for alarm annunciation for heat pump unit disable.

3.3 DOAS HEAT PUMP UNITS

A. Provide for automatic control of all 2- pipe hydronic DOAS heat pump units.

B. Provide digital interface between DOAS heat pump controllers and the Building Energy Management System. DOAS heat pump control with building automation system interface shall provide remote control and sensing of fan and valve operation, and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. DOAS heat pump units shall have in-duct sensors, rather than thermostats/humidistats. Temperature setpoints and time schedules shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. Fans shall operate continuously. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

D. Control valves shall open/close to offset outside air temperature.

E. Control valves shall be electric-operated, 2-way, 2-position type.

F. Freeze Protection: A low limit temperature sensor shall be located on the upstream side of the DOAS heat pump coil. If a temperature of 45°F (adj.) or less is detected, then the outside air damper shall fully close, and the DOAS heat pump unit shall be disabled. Upon correction of the problem, the system must be manually reset. The freeze

protection wire shall be serpentine across the entire face of the water coil approximately every four inches. Provide for alarm annunciation for DOAS heat pump unit disable.

G. Smoke Detector: A smoke detector or detectors shall be located in the supply air stream of each DOAS heat pump unit, greater than or equal to 2000 cfm. If smoke is detected, the supply fan shall de-activate. Upon correction of the problem, the system must be manually reset.

3.4 ELECTRIC PREHEAT COIL

A. Provide digital interface between electric preheat coil controllers and the Building Energy Management System. Electric coil control with building automation system interface shall provide remote control and sensing of inlet/discharge air temperatures. Provide for alarm annunciation for high/low discharge air temperatures.

B. Electric coils shall have in-duct sensors, rather than thermostats/humidistats. Temperature setpoints shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. DOAS fans shall operate continuously. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. Electric coils shall enable/disable to offset outside air temperature.

D. Electric coils shall have SCR control.

3.5 EXHAUST FANS

A. Provide digital interface between exhaust fans and the Building Energy Management System. Exhaust fan control with building automation system interface shall provide remote monitoring of fan operation.

B. Fans shall operate continuously. Provide for alarm annunciation for fan failure.

3.6 FAN COIL UNITS

A. Provide for automatic control of all 4- pipe hydronic fan coil units.

B. Provide digital interface between fan coil valve/fan controllers, and the Building Energy Management System. Fan coil control with building automation system interface shall provide remote control and sensing of fan and valve operation, and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. All sleeping room & private office thermostats indicated on construction documents shall have local control & display. Temperature setpoints, monitoring, & fan operation shall be at the individual thermostat.

D. No public thermostats indicated on construction documents shall have local control & display. Temperature setpoints and time schedules shall be adjustable through the

BMS. Monitoring shall be performed through the BMS only. Fans shall operate continuously during Occupied and cycle to offset zone heat gains/losses in Unoccupied periods.

E. Control valves shall modulate to offset space heat gains/losses.

F. Control valves shall be electric-operated, 2-position, modulating type.

3.7 FC-263 & FC-364 FAN COIL UNITS

A. Provide for automatic control of 2- pipe hydronic fan coil units.

B. Provide digital interface between fan coil valve/fan controllers, and the Building Energy Management System. Fan coil control with building automation system interface shall provide remote control and sensing of fan and valve operation, and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. No public thermostats indicated on construction documents shall have local control & display. Temperature setpoints and time schedules shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. Fans shall operate continuously during Occupied and cycle to offset zone heat gains/losses in Unoccupied periods.

D. Control valves shall open/close to offset space heat gains/losses.

E. Control valves shall be electric-operated, 2-way, 2-position type.

F. Freeze Protection: A low limit temperature sensor shall be located on the upstream side of the fan coil. If a mixed air temperature of 45°F (adj.) or less is detected, then the outside air M.O. damper shall fully close and the return air M.O. damper shall fully open, and the fan coil unit shall be disabled. Upon correction of the problem, the system must be manually reset. The freeze protection wire shall be serpentine across the entire face of the water coil approximately every four inches. Provide for alarm annunciation for fan coil unit disable.

3.8 DOAS CHILLED/HOT WATER UNITS

A. Provide for automatic control of all 4- pipe hydronic DOAS chilled/hot water units.

B. Provide digital interface between DOAS chilled/hot water controllers and the Building Energy Management System. DOAS chilled/hot water control with building automation system interface shall provide remote control and sensing of fan and valve operation, and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. DOAS chilled/hot water units shall have in-duct sensors, rather than thermostats/humidistats. Temperature setpoints and time schedules shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. Fans shall

operate continuously. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

D. Control valves shall open/close to offset outside air temperature.

E. Chilled water control valves shall be electric-operated, 3-way, modulating type. Hot water control valves shall be electric-operated, 2-way, modulating type.

F. Freeze Protection: A low limit temperature sensor shall be located on the upstream side of the DOAS chilled water coil. If a temperature of 40°F (adj.) or less is detected, then the outside air damper shall fully close, and the DOAS chilled/hot water unit shall be disabled. Upon correction of the problem, the system must be manually reset. The freeze protection wire shall be serpentine across the entire face of the water coil approximately every four inches. Provide for alarm annunciation for DOAS chilled/hot water unit disable.

G. Smoke Detector: A smoke detector or detectors shall be located in the supply air stream of each DOAS heat pump unit, greater than or equal to 2000 cfm. If smoke is detected, the supply fan shall de-activate. Upon correction of the problem, the system must be manually reset.

3.9 HYDRONIC PREHEAT COIL PUMPS

A. Provide digital interface between hydronic preheat coil pump controllers and the Building Energy Management System. Preheat coil pump control with building automation system interface shall provide remote control and sensing of inlet/discharge air temperatures. Provide for alarm annunciation for high/low discharge air temperatures.

B. Preheat coil pumps shall have in-duct sensors, rather than thermostats/humidistats. Temperature setpoints shall be adjustable through the BMS. Monitoring shall be performed through the BMS only. DOAS fans shall operate continuously. Provide for alarm annunciation for fan failure, or high/low discharge air temperatures.

C. Preheat coil valves shall be electric-operated, 3-way, modulating type, and shall modulate to offset outside air temperature.

D. If a temperature of 40°F (adj.) or less is detected, then the preheat coil pumps shall be enabled.

3.10 CHILLER

A. Provide automatic control of chiller with Building Energy Management System interface to BMS.

B. Chiller shall be furnished complete with a microcomputer control center. Digital programming of chiller setpoints shall include:
   1. Leaving chilled water temperature.
   2. Percent current limit.
   3. Pull-down demand limiting.

4. Seven day clock for starting/stopping chiller operation.
5. Pump operation.
6. Remote temperature reset.

C. All safety and cycling shutdowns shall be annunciated through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include; high condenser pressure, low oil pressure, compressor thrust bearing oil temperature, compressor thrust bearing position threshold, high oil pressure, high compressor discharge temperature, low evaporator pressure, motor controller fault, and sensor malfunction.

D. Cycling shut-downs shall include; low water temperature, power fault, internal time clock, and anti-recycle.

E. System operating information shall include: return/leaving chilled water temperatures, evaporator/condenser refrigerant pressures, differential oil pressure, percent motor current, evaporator/condenser saturation temperatures, compressor discharge temperature, oil reservoir temperatures, compressor thrust bearing position and oil temperature, and number of compressor hours.

F. Security access shall be provided to prevent unauthorized change of setpoints, to allow local or remote control of chiller, and to allow manual operation of the prerotation vanes and oil pump.

G. The operating program shall be stored in a non-volatile memory (RPROM) to eliminate chiller failure due to AC power failure/battery discharge. Programmed setpoints shall be retained in lithium battery-backed RTC memory for (5) years minimum.

H. The chillers shall be provided with an RS-232 port to output all system operating data, shutdown/cycling messages and a record of the last four cycling or safety shutdowns to a remote printer. The control center shall be programmable to provide data logs to the printer at a set time interval.

I. Control center shall be able to interface with a building automation system to provide remote chiller start/stop, reset of chilled water temperature, reset of current limit, and status messages indicating chiller is ready to start, chiller is operating, chiller is shut-down on a safety requiring reset, and chiller is shut-down on a recycling safety.

J. Chiller variable speed drive shall be factory installed. It shall vary the compressor motor speed by controlling the motor frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

K. Provide a wall mount refrigerant leak detectors with electrical interlocks to automatically shutdown all gas-fired boilers, and start-up EF exhaust fan and open relief hood O.A. damper. Detector shall automatically activate audible and visual room alarms as well as annunciate the Building Energy Management System.

L. Provide digital interface between chiller controllers, and the Building Energy Management System. Chiller control with building automation system interface shall

provide remote control and sensing of chiller operation, inlet/discharge water temperatures/flows, and loading.

M. Chillers shall provide constant discharge temperature of 44°F setpoint to be variable.

3.11 CHILLED WATER PUMPS PCHWP-1 & PCHWP-2

A. Provide for VFD automatic control of (2) base-mount chilled water pumps. VFD by Control Contractor.

B. Provide digital interface between chilled water pump motor controllers, and the Building Energy Management System. Pump control with building automation system interface shall provide remote control and sensing of pump operation, and inlet/discharge water temperatures. Provide for alarm annunciation for pump failure, or high/low temperatures/pressures.

C. (1) chilled water pump shall run continuously. Second chiller pump shall start/stop automatically with a drop in chilled water system water pressure to 95% of design system head, or the startup of the second chiller. Provide an electrical interlock with chiller water flow switch to prevent chiller start-up without adequate water flow.

D. Provide a piping system aquastat on return piping, to control VFD. Pumps shall start at minimum speed and ramp up as piping system pressure increases.

E. Provide lead/lag pump operation with an alternating start sequence to equalize pump run time.

3.12 CHILLED WATER PUMPS SCHWP-1 & SCHWP-2

A. Provide for VFD automatic control of (2) base-mount chilled water pumps. VFD by Control Contractor.

B. Provide digital interface between chilled water pump motor controllers, and the Building Energy Management System. Pump control with building automation system interface shall provide remote control and sensing of pump operation, and inlet/discharge water temperatures. Provide for alarm annunciation for pump failure, or high/low temperatures/pressures.

C. Pumps shall start/stop automatically. (1) pump shall operate continuously with (1) pump in standby.

D. Provide a piping system pressure sensor located at 2/3 location along piping loop, to control VFD. Pumps shall start at minimum speed and ramp up as piping system pressure increases.

E. Provide lead/lag pump operation with an alternating start sequence to equalize pump run time.

3.13 HEATING HOT WATER PUMPS SHHWP-1 & SHHWP-2

A. Provide for automatic VFD control of (2) hot water pumps. VFD by Control Contractor.

B. Provide digital interface between pump motor controllers, and the Building Energy Management System. Pump control with building automation system interface shall provide remote control and sensing of pump operation, and inlet/discharge water temperatures. Provide for alarm annunciation for pump failure, or high/low temperatures/pressures.

C. Pumps shall start/stop automatically. (1) pump shall operate continuously with (1) pump in standby.

D. Provide a piping system pressure sensor located at 2/3 location along piping loop, to control VFD. Pumps shall start at minimum speed and ramp up as piping system pressure increases.

E. Provide lead/lag pump operation with an alternating start sequence to equalize pump run time.

3.14 MAKE-UP WATER

A. Provide for sensing switch, meter, & control valve for chilled & heating hot water make-up.

B. Control valve shall close if the make-up water continues flowing at a rate of 3 gallons per minute after a time delay of 2 minutes (adjustable), while the system switch is in the normal operating position.

C. Upon control valve closing, alarm shall be sent through Building Energy Management System, to alert maintenance personnel.

3.15 START-UP / TESTING

A. The Building Energy Management System shall be started up in phases agreed to by the Owner.

B. Prior to testing and verifying proper system operation, Contractor shall furnish the Owner and Engineer, for acceptance two (2) copies each of the start-up/testing procedure proposed. Owner and Engineer will review the check-out procedure prior to start-up/testing.

C. After the procedure is reviewed and after installation is complete and systems are ready to be placed into regular service, Contractor shall inform the Owner of this fact in writing.

D. Contractor shall agree on a start-up date with Owner and Engineer.

E. During start-up period Contractor shall have on-site qualified field technicians to place the system in operation, marking such tests, adjustments and changes as may be found

necessary to insure successful operation of the installed equipment and systems. All tests shall be documented by the Contractor and certified, verifying that the tests have been performed and that all deficiencies have been corrected. All testing must be performed and all deficiencies corrected to Owner's satisfaction.

3.16 TRAINING

A. At the completion of the project, TCC shall provide 2 hours of training for the Building Energy Management System. The training shall be presented in one (1) 2-hour session as selected by the owner.

B. At the end of the 11th month warranty period, TCC shall provide one (1) 2-hour training session.

END OF SECTION 23 09 93

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For each type of product indicated.
2. For solvent cements and adhesive primers, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 150 psig at 200 deg F.
2. Chilled-Water Piping: 150 psig at 200 deg F.
3. Condenser-Water Piping: 150 psig at 150 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Condensate-Drain Piping: 150 deg F.
6. Blowdown-Drain Piping: 200 deg F.
7. Air-Vent Piping: 200 deg F.
8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 PIPES, TUBES, AND FITTINGS

A. Hard Copper Tubing: ASTM B 88, Type L with ASME B16.22 wrought-copper solder fittings and ASTM B 32, 95-5 tin antimony solder.

B. Soft Copper Tubing: ASTM B 88, Type K with ASME B16.22 wrought-copper solder fittings.

C. Steel Pipe: ASTM A 53, Schedule 40, plain ends with malleable-iron threaded fittings, Class 150.

D. Unions: ASME B16.39, malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

E. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure, 250 deg F maximum operating temperature.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, ends.

2.3 SPECIAL-DUTY VALVES

A. Calibrated Plug Valves: 150-psig water working pressure, 250 deg F maximum operating temperature; bronze body with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening.

B. Pressure-Reducing Valves: Diaphragm-operated, cast-iron or brass-body valve, with low-inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem.

C. Safety Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heat capacity; according to ASME Boiler and Pressure Vessel Code: Section IV.

2.4 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Diaphragm-Type Expansion Tanks: Welded carbon steel, 150-psig working pressure, 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled according to ASME Pressure Vessel Code: Section VIII.

C. Chemical Feeder: 5-gal., bypass-type, welded steel; 150-psig working pressure; complete with fill funnel and inlet, outlet, and drain valves. Furnish chemicals specially formulated to prevent accumulation of scale and corrosion (both detergent & corrosion inhibitor) in piping system and connected equipment, developed based on analysis of makeup water.

D. Y-Pattern Strainers: 150-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection.

E. Steel to PVC Pipe Connectors: Utilize new manufactured threaded-to-solvent fittings by Spear or equal. Contractor may also use flanged connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements in Section 230500 "Common Work Results for HVAC" for basic piping installation requirements.

B. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Section 230500 "Common Work Results for HVAC" for wall penetration systems.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping free of sags and bends and install fittings for changes in direction and branch connections.

E. Use the fewest number of joints belowground and within floor slabs.

F. Install piping at a uniform slope of 0.2 percent upward in the direction of flow.

G. Make reductions in pipe sizes using eccentric reducer fitting installed with level side up.

H. Install branch connections to mains using tee fittings in main with takeoff out the bottom of the main, except for up-feed risers, which shall have swing joint and takeoff out the top of the main line.

I. Install unions in pipes adjacent to each valve, at final connections with each piece of equipment, and elsewhere as indicated.

J. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration-producing equipment.

K. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before soldering or brazing.

L. Provide manual air vents at all coil return ports.

M. Provide chemical feeders for chilled & heating hot water systems.

3.2 VALVE INSTALLATIONS

A. Shutoff Duty: Use gate or ball valves.

B. Throttling Duty: Use globe or ball valves.

C. Install shutoff-duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

D. Install throttling-duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

E. Install calibrated plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

F. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.

G. Install check valves on each pump discharge and elsewhere as required to control flow direction.

H. Install safety relief valves on hot-water generators and elsewhere as required by authorities having jurisdiction. Pipe discharge to floor drain without valves.

I. Install manual air vents at high points in the system, at heat-transfer coils, and elsewhere as required for system air venting.

J. Run piping from boiler air vent connection or air separator to compression tank with 1/4 inch per foot upward slope towards tank. Connect boiler outlet piping.

K. Install valves with stem up. Allow clearance above stem for check mechanism removal.

L. Install full-pipe size water meter immediately upstream of all pressure-reducing valves on chilled & heating hot water make-up systems. Ensure meter is able to be accessed easily from floor level.

3.3 SPECIALTIES INSTALLATIONS

A. Install chemical feeders in each hydronic system in upright position with top of funnel not more than 48 inches above floor. Install feeder across pump or in bypass line, off main using ball valves on each side of feeder, and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

B. Install diaphragm-type compression tanks on floor. Vent and purge air from hydronic system; charge tank with proper air charge to suit system design requirements.

C. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated.

3.4 TESTING, ADJUSTING, AND BALANCING

A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens.

B. Hydrostatically test completed piping at a pressure one and one-half times operating pressure. Isolate equipment before testing piping. Repair leaks and retest piping until there are no leaks.

C. Balance water flow as required by Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.5 PIPING SCHEDULE

A. Hot and Chilled Water:

1. Aboveground: Drawn-temper copper tubing with soldered joints, or steel pipe with threaded joints. Piping to be insulated.
2. Aboveground: Steel pipe with mechanical grooved joints equal to "Victaulic". Piping to be insulated.

B. Condensate Drain Lines: Drawn-temper copper tubing with soldered joints or PVC pipe with solvent-welded joints. Piping to be insulated.

END OF SECTION 23 21 13

SECTION 23 21 23 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general provisions common to HVAC pumps and circulators.

B. Particular pump types are included in respective complementary Sections immediately following this Section. Refer to Project Manual "Table of Contents" for respective Pump Section titles.

C. Applicable general provisions in this Section govern pumps included in respective complementary Sections the same as if repeated in respective Sections.

D. Pumps furnished as a part of the work of this Project shall comply with provisions of this Section and applicable specifications in respective pump type Sections.

E. Applicable provisions of Sections 230500, and respective related product and system Sections, govern work of this Section and respective complementary Sections.

F. Concrete Bases are specified.

G. Vibration Control is specified in Section 230548.

H. Testing, Adjusting, and Balancing are specified in Section 230593.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Pumps shall be provided and installed by Mechanical contractor.

1. Contractor shall coordinate delivery of equipment to site, unloading, necessary site storage in acceptable weatherproof, vandal proof location, equipment pad, installation and startup. Advise Engineer of equipment startup and water balance.
2. Coordinate factory startup of all equipment with vendor.

B. Acceptable Manufacturers

1. Grundfos
2. B&G

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions effecting performance of pumps.

B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PUMPS, GENERAL

A. Install pumps as shown on drawings, in accordance with manufacturer's written instructions, with proper clearance and access for inspection and servicing.

B. Install base-mounted pumps on 4" concrete base specified, set level, grouted in place; properly isolated to control vibration transmission.

C. Pump Connections: Decrease piping from line size to pump connection size with long radius reducing elbows or reducers. Provide line size shut-off valve and strainer on pump suction. Provide line size soft seat check valve and balancing valve on pump discharge.

1. Flexible Connectors: Installation of (3) Victaulic couplings. Provide on suction and discharge side of each base-mounted pump, located between pump casing and discharge valves and upstream from straining device, unless indicated otherwise for a particular installation.

D. Provide air cock and drain connection on horizontal pump casings.

E. Inline Pumps: Suspend, using hanger rods and vibration isolation hangers sufficient size to support pump weight independent from piping system.

F. Base-Mounted Pumps: Set on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed. Procure services of a qualified millwright to check, align, and certify base mounted pumps prior to startup. Shim pump base to level pump and driver shafts and place grout between base and foundation. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment in accordance with methods in Hydraulic Institute document "Centrifugal Pumps – Instructions for Installation, Operation and Maintenance".

G. Provide drains for bases and seals, piped to and discharging into floor drains.

H. Where multiple pumps are manifold together, provide interconnecting piping, valves, fittings, meters, gauges, etc.

I. Provide valve and union or flanged connection at suction and discharge of each pump to enable servicing or isolation of individual pumps.

J. Properly align, space, and separately support pipe and devices connected to pumps to ensure that weight of attached items is not supported by pump and that connection does not apply stress to pump.

K. Provide pressure gages, equipped with gage valves, installed in suction and discharge of each pump.

3.3 COMMISSIONING

A. Prior to pump start-up, perform the following on each pump:

1. Check alignment and installation of flexible couplings and other drive components to assure shafts are properly aligned and drive components are securely in place.
2. With coupling disconnected, check motor for proper rotation.
3. Lubricate pumps, following manufacturer's written instructions.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If pump is bound or drags slightly, do not operate pump until cause of trouble is determined and corrected.

B. Start-up pumps, following manufacturer's written instructions.

C. Mechanical Contractor shall provide a minimum (8) hours training session for Owner's maintenance personnel on chiller, pumps, and VFD's. Training shall include, but not limited to, seasonal start-up and shutdown, scheduled maintenance, and troubleshooting.

3.4 OPERATIONAL CHECK OF PUMPS

A. Check to ensure pumps operate at specified fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

END OF SECTION 23 21 23

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following HVAC water-treatment systems:

1. Manual chemical-feed equipment and controls.

B. Owner's chemical supplier is Global Water Technology (GWT) in South Holland, Illinois. Contact Andy McGill at amcgill@gwt-inc.com or 270-823-3228 for proposals. This scope does not include any work associated with the domestic water softener system & meters, which would be subcontracted underneath the Mechanical Construction contract with either GWT or other qualified vendors.

PART 2 - PRODUCTS

2.1 TREATMENT EQUIPMENT

A. One-Shot Feeder:

1. Base Bid: No one-shot chemical bypass feeders are necessary.
2. Alternate: Furnish and install (3) temporary one-shot chemical bypass feeders on new portions of primary & secondary chilled systems and hot water system. Provide side filter.
3. Each feeder shall be 5 gallon volume as required to initially treat the system served in two shots. Pressure rating shall be 150 psig or 300 psig to match other valve and pressure vessel ratings. Provide fill funnel and valve, air vent cock, and drain valve and plug.
4. Neptune, #FTF-5DB.

B. Detergent & Corrosion Inhibitor:

1. Base Bid and Alternate: Provided & installed by Owner's chemical supplier. Paid for by Mechanical Construction contract, with Owner's chemical supplier as a subcontractor.

C. Chemicals:

1. Base Bid: No chemicals are necessary.

2. Alternate: Provided & installed by Owner's chemical supplier. Paid for by Mechanical Construction contract, with Owner's chemical supplier as a subcontractor.

PART 3 - EXECUTION

3.1 SYSTEM CLEANING AND INITIAL WATER TREATMENT

A. System cleaning and initial chilled and heating water treatment shall be in accordance with the following procedure:

1. Coordinate with Owner's chemical supplier.
2. With strainers in place and all control valves open, circulate water for 2 hours at a minimum velocity of 5 to 6 fps. Provide temporary circulation pumps with fine mesh strainers of sufficient capacity to achieve the required velocities.
3. Clean all strainers and repeat step one. Continue to repeat the process until all strainers are clean and completely free of debris.
4. Drain enough water to add cleaner to system. Owner's chemical supplier to add chemicals.
5. Circulate cleaner solution for 24 hours. Completely drain to waste tanks and follow applicable local, state, and federal regulations for waste disposal.
6. Fill new portions of system with water. Open piping to existing central heating and chilled water piping. Allow to circulate for 48 hours.
7. Monitor system chemical treatment for several days.
8. Clean all strainers prior to placing in service.

END OF SECTION 23 25 00

SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCT AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; galvanized.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

8. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.6 HANGARS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

M. Provide turning vanes at all supply duct elbows, and air extractors at all supply duct perpendicular flow branches.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

D. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGAR AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected to Self-Contained Units, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive 3-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

2. Ducts connected to RTUs, and MUA

    a. Pressure Class: Positive 5–inch wg.

C. Return Ducts:

1. Ducts Connected to Self-Contained Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting Air:

    a. Pressure Class: Negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

F. Liner:

1. Transfer Ducts: Fibrous glass, Type I, 1/2 inch thick.
2. Return air for all Fan Coils

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

    a. Velocity 1000 fpm or Lower:

        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.

    b. Velocity 1000 to 1500 fpm:

        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

    c. Velocity 1500 fpm or Higher:

        1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to Diameter Ratio: 1.5.

   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 32 00 – LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.

1.2 PERFORMANCE REQUIREMENTS

A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.3 REFERENCES

A. AAMA 605.2 - High Performance Organic Coatings on Architectural Extrusions and Panels.

B. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

C. AMCA 511 - Certified Ratings Program for Air Control Devices.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data including performance data.

B. Shop Drawings: Submit shop drawings indicating materials, construction, dimensions, accessories, color chart and installation details.

C. Samples: Submit sample of louver to show frame, blades, bird screen, gutters, downspouts, vertical supports, sill, accessories, finish, and color.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.

1.6 QUALITY ASSURANCE

A. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
2. For color-finished louvers, use fasteners with heads that match color of louvers.

2.2 FABRICATION, GENERAL

A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

B. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Storm-Resistant Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

    a. Greenheck Fan Corporation.
    b. Ruskin Company; Tomkins PLC.
    c. Nailor.

2. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
3. Louver Performance Ratings:

    a. Free Area: Not less than 50 percent
    b. Air Performance: Not more than 0.10-inch wg. static pressure drop at 400-fpm free-area intake velocity.

4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide bird screen at each exterior louver.

B. Louver Screen Frames: Same kind and form of metal as indicated for louver to which screens are attached.

C. Louver Screening:

1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.
2. Bird Screening: Stainless steel, 1/2-inch- square mesh, 0.047-inch wire.
3. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch thick.
4. Bird Screening: Galvanized steel, 1/2-inch- square mesh, 0.041-inch wire.

2.5 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color and Gloss: As selected by Architect from manufacturer's full range color chart.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.

C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory and refinish entire unit or provide new units.

E. Protect galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint.

3.3 CLEANING

A. Clean louver surfaces in accordance with manufacturer's instructions.

B. Repair minor damaged surfaces as directed by Architect.

END OF SECTION 23 32 00

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire dampers.
3. Radiation dampers.
4. Smoke dampers.
5. Combination fire/smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

1.2 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.
2. Product certificates.
3. Field quality-control test reports.
4. Wiring Diagrams.
5. Warranty: Sample of warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: ect to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

a. Air Balance Inc.; a division of Mestek, Inc.
b. Cesco Products; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. Ruskin Company.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

2.3 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Greenheck Fan Corporation.
2. Ruskin Company.
3. Nailor.
4. Pottorff.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.4 RADIATION DAMPER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Greenheck Fan Corporation.
2. Ruskin Company.
3. Nailor.
4. Pottorff.
5. Panasonic.

B. Type: Dynamic; rated and labeled according to UL 555, UL555C and NFPA 90.

C. Fire Rating: 2 hours, for use in UL floor/ceiling assembly.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners. Contractor shall verify mounting with ceiling and structure type.

E. Mounting Orientation: Horizontal ceiling mounted.

F. Blades: Hindged door, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

G. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

H. Unit shall be compatible with scheduled ceiling mounted exhaust fan.

2.5 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with mechanically attached corners and mounting flange.

E. Smoke Detector: Provide and wired by division 26.

F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-)] thick, galvanized sheet steel.

G. Leakage: Class I.

H. Rated pressure and velocity to exceed design airflow conditions.

I. Mounting Sleeve: Factory-installed, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

J. Damper Motors: Two-position action.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
7. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, remote mounted.

2.6 COMDINATION FIRE/SMOKE DAMPERS

A. Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Ruskin Company.

4. Nailor.
5. Pottorff.

C. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

E. Fire Rating: 1-1/2 hours.

F. Frame: Multiple-blade type Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-(0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

G. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

H. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

I. Smoke Detector: Provide and wired by division 26.

J. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

K. Leakage: Class I class.

L. Rated pressure and velocity to exceed design airflow conditions.

M. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

N. Damper Motors: Two-position action.

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and

breakaway torque rating of 150 in. x lbf (17 N x m).

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
7. Electrical Connection: 115 V, single phase, 60 Hz.

P. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, remote mounted.

Q. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, remote mounted.

2.7 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Ductmate Industries, Inc.
2. METALAIRE, Inc.
3. SEMCO Incorporated.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct

mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Single wall.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Greenheck Fan Corporation.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in

the filling.

3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

2.12 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire dampers according to UL listing.

G. Install radiation dampers according to UL listing.

H. Install smoke dampers according to UL listing.

I. Install fire/smoke dampers according to UL listing.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
2. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
3. Upstream from turning vanes.
4. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Install flexible connectors to connect ducts to equipment.

M. Connect terminal units to supply ducts directly. Do not use flexible ducts to change directions.

N. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with liquid adhesive plus tape.

P. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and fire/smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 00 – FANS, EXHAUSTERS, AND VENTILATORS, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general provisions, product requirements, and specifications common to Fans, Exhausters, Ventilators, and accessories.

B. Particular fan, exhauster, and ventilator types are included in respective complementary Sections immediately following this Section. Refer to Project Manual "Table of Contents" for respective product Section titles. If a particular product is indicated on Drawings and not included in a complementary Section in Project Manual, applicable provisions of this Section and construction and features of product referenced on Drawings shall govern respective product furnished for the application.

C. Applicable general provisions in this Section govern fans, exhausters, and ventilators included in respective complementary Sections the same as if repeated in respective Sections.

D. Fans, exhausters, and ventilators furnished as a part of the work of this Project shall comply with applicable provisions of this Section, specifications in respective fan, exhauster, and ventilator type Sections, and schedules and notes on Drawings. Specifications for particular type units have precedence over similar general provisions of this Section.

E. Applicable provisions of Sections 230500 and respective related product and system Sections, govern work of this Section and respective complementary Sections.

F. Roof Curbs and Equipment Support Rails are specified in Section 230500.

G. Vibration Control is specified in Section 230548.

H. Flexible Duct Connections are Specified in Section 233100.

I. Testing, Adjusting, and Balancing are specified in Section 230593.

J. Control and sequence of operation provisions are specified in respective Temperature Control Sections. Refer to Project Manual "Table of Contents" for respective automatic Temperature Control Section titles.

1.2 REFERENCES

A. Standards and documents referenced in text of this and complementary Sections shall be the edition current at date Project Manual was issued.

B. AFBMA (Anti-Friction Bearing Manufacturers Association)

1. AFBMA Std 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. AFBMA Std 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. AMCA (Air Movement and Control Association, Inc.)

1. AMCA 99 - Standards Handbook.
2. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
3. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
4. AMCA 301 - Method of Calculating Fan Sound Ratings from Lab Test Data.

D. NEMA (National Electrical Manufacturers Association)

1. NEMA MG-i - Motors and Generators.

1.3 DESIGN AND PERFORMANCE REQUIREMENTS

A. Design Criteria: Drawings indicate sizes, profiles, connections, dimensional requirements, etc. of fans, exhausters, and ventilators, based on referenced products. Products having equivalent performance characteristics by other manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies are suitable for the application and do not change the design concept or intended performance as judged by Architect/Engineer.

B. Furnished Fans: Capable of accommodating static pressure variations of plus or minus 10%; have performance that does not vary from specified criteria more than the following:

1. Not have decreased motor size, or increased noise level
2. Not have tip speed increased by more than 10%.
3. Not have inlet air velocity increased by more than 20%.

1.4 SUBMITTALS

A. Submit product data and shop drawings for each fan, exhauster, ventilator, fan curb, and accessory to be installed on this Project, in accordance with provisions of Section 230500. Submittals shall include, but not be limited to, the following:

1. Manufacturer's drawings detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location of field connections.
2. Fan curves for proposed units, with system operating conditions clearly indicated.
3. Sound power ratings for both fan inlet and outlet at rated capacity.
4. Motor ratings and electrical characteristics, plus motor and fan accessories.

5. Damper data, including housings, linkages, and operators.
6. Manufacturer's product certification, where applicable.

B. Operation and maintenance data shall comply with provisions of Section 230500 and also include instructions for lubrication, motor and drive replacement part numbers, availability, and service depot location and telephone number.

1.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing and experienced in manufacture, assembly, and field performance of fans, exhausters, and ventilators; not less than three years in business.

B. Single Source Responsibility: In general, all fans, exhausters, and ventilators shall be the products of a single manufacturer. All units of each particular type shall be the products of a single manufacturer.

C. Fabrication: Conform to AMCA 99.

D. Performance Ratings: Based on tests made in conformance with AMCA 210.

E. Sound Ratings: Determined by AMCA 301, tested per AMCA 300.

F. NEMA Compliance: Provide electric motors and components that are NEMA listed and labeled.

G. Performance and Sound Rating Certification: Manufacturers shall certify that their products comply with specified requirements.

1.6 DELIVERY, STORANGE, AND HANDLING

A. Deliver products to site, properly store, and protect under applicable provisions of Section 230500.

B. Protect motors, shafts, and bearings from weather and construction dust.

C. If units must be stored outside for a prolonged period, remove motors and belts and store them inside a weathertight structure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Listed in respective fan, exhauster, and ventilator type complementary Sections.

B. Reference Product(s): Scheduled or noted on Drawings.

2.2 FANS, EXHAUSTERS, AND VENTILATORS, GENERAL

A. Type, Size, Performance, Characteristics, Arrangement, Accessories, Etc.: As scheduled or noted on Drawings for respective application; acceptable equivalent to products referenced on Drawings.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

C. Motors: Comply with applicable general provisions of Section 15170; designed for continuous operation in 40^0C environment, for temperature rise in accordance with NEMA MG-i limits for insulation class, service factor, and motor enclosure type; type specified, scheduled, or noted for respective units; open drip-proof type, except where specifically specified or noted otherwise for respective fans.

D. V-Belt Drives: 1.4 minimum service factor; fixed or adjustable type depending on motor horsepower and specifications for respective unit, generally as follows:

1. 15 HP and Under: Variable and adjustable pitch sheaves, selected so required rpm is obtained with sheaves set at mid-position.
2. 20 HP and Over: Fixed sheave, matched belts, rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
3. Sheaves: Cast iron or steel, dynamically balanced, keyed to shaft;
4. Belts: Oil-resistant, nonsparking, and nonstatic.
5. Belt Guard: Provide for all belt drives not enclosed in fan housing; fabricated from diamond mesh expanded metal or sheet stock; welded assembly with frame and mounting brackets, with provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place; secured to fan or fan support without short circuiting vibration isolation.

E. Lubrication Fittings: Extend to outside of casing.

F. Disconnect Switch: Nonfusible type, with thermal overload protection, unless indicated otherwise for a particular unit.

G. Special Features for Corrosive Environments: Provide for particular units when noted or scheduled on Drawings, corrosive protective coatings, Heresite or acceptable equivalent.

H. Special Features for Hazardous Environments: Provide for particular units when noted or scheduled on Drawings, spark-proof fan wheels and explosion-proof motors.

2.3 ROOF CURBS

A. Curbs: Prefabricated, specified in Section 230500.

B. Procure curbs with respective units when available from unit manufacturer.

C. Sound Attenuating Type: Curbs: Provide where indicated for respective units.

D. Verify curb manufacturer has coordinated curbs with respective units and roof construction prior to release for shipment.

2.4 BACKDRAFT DAMPERS

A. Multi-blade, gravity activated, balanced design; have blades linked together for parallel operation; equipped with aluminum blades pivoted on nylon bushings and resilient seals on blade closing edges; assembled in a heavy galvanized steel frame with provisions for conduit to pass through perimeter of damper without interfering with damper operation; factory set to close when fan stops.

B. Vertical Dampers: Equipped with adjustable counterweight or spring loaded for optimum operation.

2.5 FAN SPEED CONTROLS

A. Single Phase Speed Controls: Multiple speed selector switches or solid state variable speed controllers as indicated on Drawings; for wall mounting; furnished by respective fan manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, roof curbs, equipment supports, ductwork, and other conditions effecting performance of fans.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FANS, EXHAUSTERS, AND VENTILATORS - COMMON REQUIREMENTS

A. Install units level and plumb. Align, lubricate, start, and balance units in accordance with manufacturer's written instructions, with proper clearance and access for inspection and servicing.

B. Install roof mounted units on roof curbs or equipment support rails, as applicable. Secure units to curbs and rails with cadmium-plated hardware, properly isolated against vibration.

C. Install units with resilient mountings and flexible electrical leads.

D. Provide flexible duct connections between fans and connecting ductwork. Ensure metal components of flexible connections are parallel and have one inch minimum flex between ductwork and fan while running.

E. Install fan related items in a manner that will ensure vibration isolation provisions are not short circuited.

F. Install fan restraining snubbers where side torque or thrust may develop and where indicated on Drawings. Flexible connections shall not be in tension while fan is running.

G. Provide backdraft dampers for exhaust fans, arranged as indicated.

H. Provide safety screen where fan inlet or outlet is exposed.

I. Provide fixed sheaves where required for final air balance.

J. Provide speed controllers where indicated on Drawings for particular fans.

3.3 ADJUSTING AND CLEANING

A. Check damper operation and linkages. Adjust for proper damper operation.

B. Clean exterior and interior of each unit. Vacuum clean fan wheel and surfaces exposed to air handled by the unit.

3.4 FAN, EXHAUSTER, AND VENTILATOR COMMISSIONING

A. Perform following operations and checks before units are operated for any purpose:

1. Verify shipping blocking and bracing have been removed.
2. Verify unit is secure on mountings and supporting devices and connections for ductwork, electrical, etc. are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform specified cleaning and adjusting.
4. Disconnect fan drives from motors, verify proper motor rotation, and verify fan wheel free rotation and smooth operation of bearings. Reconnect fan drive systems, align belts, and install belt guards.
5. Lubricate bearings and other moving parts with factory-recommended 1ubricants.
6. Verify manual and automatic volume control dampers are positioned properly and that fire and smoke dampers in related ductwork are in full-open position.
7. Disable automatic temperature control operators, where applicable.

B. Energize fan motors and adjust fans to indicated RPM. Replace fan and motor pulleys as required to achieve design conditions.

C. Shut units down and reconnect automatic temperature controls

D. Refer to Section 230593 for testing, adjusting, and balancing provisions.

3.5 DEMONSTRATION

A. Demonstrate equipment operation to Owner's operating and maintenance personnel. Instruct personnel in procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.

B. Familiarize personnel with contents of Operating and Maintenance Manuals.

C. Schedule demonstration and instruction with at least 7 days advance notice.

END OF SECTION 23 34 00

SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Adjustable bar registers and grilles.
4. Fixed face registers and grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

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

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
3. Color chart.

B. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Product data.
2. Product certificates.
3. Source quality-control reports.
4. Field quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):

1. Anemostat.
2. Krueger.
3. Metalaire.
4. Price.
5. Titus.
6. Tuttle & Bailey.
7. Nailor.

B. Provide thermally adjustable diffusers manufactured by Acutherm.

2.2 CEILING DIFFUSERS

A. Square Ceiling Diffusers:

1. As specified on drawing schedule.

2.3 DUCT DIFFUSERS

A. Duct Diffusers:

1. As specified on drawing schedule.

2.4 REGISTERS AND GRILLES

A. Return/Transfer Grille:

1. Grilles shall be of aluminum construction, consisting of aluminum 1/2" x 1/2" x 1/2" grid and an extruded aluminum border.
2. The grille shall be finished in B12 White Powder Coat.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 64 25 - AIR COOLED SCROLL LIQUID CHILLER

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of this Section shall conform to the general provisions of the Contract, including General and Supplementary Conditions, Conditions of the Contract, and Contract Drawings.

1.2 SCOPE

A. Provide Microprocessor controlled, multiple scroll compressor, air-cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:
   1. Chiller package
   2. Charge of refrigerant and oil
   3. Electrical power and control connections
   4. Chilled liquid connections
   5. Manufacturer start-up

1.3 QUALITY ASSURANCE

A. Products shall be Designed, Tested, Rated and Certified in accordance with, and Installed in compliance with applicable sections of the following Standards and Codes:

   1. AHRI 550/590 – Water Chilling Packages Using the Vapor Compression Cycle
   2. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
   3. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration
   4. ANSI/ASHRAE 34 – Number Designation and Safety Classification of Refrigerants
   5. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
   6. ANSI/NFPA 70 – National Electrical Code (N.E.C.)
   7. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
   8. OSHA – Occupational Safety and Health Act
   9. Manufactured in facility registered to ISO 9001
   10. Conform to Intertek Testing Services for construction of chillers and provide ETL/cETL Listed Mark

B. Factory Run Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

C. Chiller manufacturer shall have a factory trained and supported service organization.

D. Manufacturer shall Warrant all equipment and material of its manufacture against defects in workmanship and material for a period of thirty (30) months from date of shipment or twenty-four (24) months from date of start-up, whichever occurs first. Contractor shall provide an associated labor warranty matching this same 30/24-month manufacturer's warranty. Contractor shall also provide a standard 1-year parts & labor warranty for all non-manufacturer-related defects.

E. Manufacturer shall Warrant compressors for five (5) years from date of start-up. Contractor is not required to match this manufacturer's warranty for Years 3-5.

F. Engage a factory-authorized service representative to perform (3) additional on-site equipment inspections, to be scheduled through Owner. These inspections are to occur at regular intervals throughout the first 2-years of chiller operation, and shall include all tests, inspections, & reports as performed during the initial equipment start-up.

1.4 DELIVERY AND HANDLING

A. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.

B. Provide protective covering over vulnerable components for unit protection during shipment. Fit nozzles and open ends with plastic enclosures.

C. Unit shall be stored and handled per Manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Quantech

2.2 CHILLER MATERIALS AND COMPONENTS

A. General: Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air cooled scroll compressor chiller(s) as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with Flammability rating of "1", as defined by ANSI/ASHRAE STANDARD 34 Number Designation and Safety Classification of Refrigerants. Chiller shall include not less than two refrigerant circuits above 50 tons (200kW), scroll compressors, direct-expansion type

evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components and special features as specified herein or required for safe, automatic operation.

B. Cabinet: External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1000 hour, 5% salt spray test, yields minimum ASTM 1654 rating of "6".

C. Operating Characteristics: Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 30°F to 115°F (-1°C to 46°C) ambient temperature.

D. Service Isolation valves: Discharge (ball type) isolation valves field installed per refrigerant circuit. Includes a system high-pressure relief valve in compliance with ASHRAE15.

E. Pressure Transducers and Read-out Capability

1. Discharge Pressure Transducers: Permits unit to sense and display discharge pressure.
2. Suction Pressure Transducers: Permits unit to sense and display suction pressure.
3. High Ambient Control: Allows units to operate when the ambient temperature is above 115°F. Includes discharge pressure transducers

2.3 COMPRESSORS

A. Compressors: Shall be hermetic, scroll-type, including:

1. Compliant design for axial and radial sealing.
2. Refrigerant flow through the compressor with 100% suction cooled motor.
3. Large suction side free volume and oil sump to provide liquid handling capability.
4. Compressor crankcase heaters to provide extra liquid migration protection.
5. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown and reverse rotation protection.
6. Initial oil charge.
7. Oil level sight glass.
8. Vibration isolator mounts for compressors.
9. Brazed-type connections for fully hermetic refrigerant circuits.
10. Compressor Motor overloads capable of monitoring compressor motor current. Provides extra protection against compressor reverse rotation, phase-loss and phase-imbalance.

2.4 REFRIGERANT CIRCUIT COMPONENTS

A. Each refrigerant circuit shall include: a discharge service ball type isolation valve, high side pressure relief, liquid line shutoff valve with charging port, low side pressure relief device, filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line and suction pressure transducer.

2.5 HEAT EXCHANGERS

A. Remote Evaporator:

1. Evaporator shall be brazed-plate stainless steel construction capable of refrigerant working pressure of 650 psig and liquid side pressure of 150 psig.
2. Brazed plate heat exchangers shall be UL listed.
3. Water nozzles shall be provided with grooves for field provided ANSI/AWWA C-606 mechanical couplings.
4. Evaporator shall include vent and drain fittings and thermostatically controlled heaters to protect to -20°F (- 29°C) ambient in off-cycle.
5. A 20-mesh, serviceable wye-strainer and mechanical couplings shall be provided for field installation on evaporator inlet prior to startup.
6. Evaporator shall be provided with piping extension kit and mechanical couplings to extend liquid connection from evaporator to edge of unit. Thermal dispersion type flow switch shall be factory installed in the evaporator outlet pipe extension and wired to the unit control panel. Insulation and heat trace on piping shall be responsibility of installing contractor. Extension kit nozzle connections shall be ANSI/AWWA C-606 (grooved).

B. Air-cooled Condenser:

1. Coils: Condenser coils shall be constructed of a single material to avoid galvanic corrosion due to dissimilar metals. Coils and headers are brazed as one piece. Integral sub cooling is included. Coils shall be designed for a design working pressure of 650 PSIG. Condenser coil shall be washable with potable water under 100 psi pressure.
2. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class "F", current-protected, Totally Enclosed Air-Over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.
3. Low Sound Fans with Variable Speed Drives. All fans shall be powered by VSDs. Fans shall provide vertical air discharge from extended orifices. Fans shall be composed of corrosion resistant aluminum hub and glass-fiber-reinforced polypropylene composite blades molded into a low-noise airfoil section. Fan impeller shall be dynamically balanced for vibration-free operation. Fan guards of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel.

2.6 CONTROLS

A. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.

B. Power/Control Enclosure: Rain and dust tight NEMA 3R powder painted steel cabinet with hinged, latched, and gasket sealed door.

C. Microprocessor Control Center:

1. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pump down at system shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from -10°F to

125°F (-23°C to 52°C) ambient. Automatic reset to normal chiller operation after power failure.

2. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real-time-clock (RTC) memory for minimum 5 years.
3. Forty character liquid crystal display, descriptions in English (or Spanish, French, Italian, or German), numeric data in English (or Metric) units. Sealed keypad with sections for Setpoints, Display/Print, Entry, Unit Options & clock, and On/Off Switch.
4. Programmable Setpoints (within Manufacturer limits): display language; chilled liquid temperature setpoint and range, remote reset temperature range, daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).
5. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, liquid temperature reset via a 4-20milliamp or 0-10 VDC input, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status, water pump status.
6. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. System Safeties include: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
7. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation.
8. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.
9. BAS Communications: BACnet MS/TP, Modbus and N2 communication capabilities are standard.

D. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.7 POWER CONNECTION AND DISTRIBUTION

A. Power Panels:

1. NEMA 3R/12 rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.

2. Power supply shall enter unit at a single location, be 3 phase of scheduled voltage, and connect to individual terminal blocks per compressor. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.

B. Compressor, control and fan motor power wiring shall be located in an enclosed panel or routed through liquid tight conduit.

2.8 ACCESSORIES AND OPTIONS

A. Microprocessor-controlled, factory-installed across-the-Line type compressor motor starters as standard.

B. Power Supply Connections:

1. Single Point Circuit Breaker w/ Lockable Handle & 65kA SCWR

C. Control Power Transformer: Converts unit power voltage to 120-1-60 (500 VA capacity). Factory-mounting includes primary and secondary wiring between the transformer and the control panel.

D. Protective Chiller Panels (Factory or Field Mounted)

1. Louvered/Wire Panels: Louvered steel panels on external condenser coils painted as per remainder of unit cabinet. Heavy gauge, welded wire-mesh, coated to resist corrosion, around base of machine to restrict unauthorized access.

E. Thermal Dispersion Flow Switch (Factory installed and wired in piping extension kit): Normally open, 30bar pressure rating, stainless steel 316L construction, IP67, -4°F to 158°F ambient rating.

F. Hot Gas By-Pass: Permits continuous, stable operation at capacities below the minimum step of unloading to as low as 5% capacity (depending on both the unit & operating conditions) by introducing an artificial load on the evaporator. Hot gas by-pass is installed on only one refrigerant circuit.

G. Low Temperature Process Glycol: Leaving chilled liquid setpoint range 10°F to 50°F (-12°C to 10°C)

H. Vibration Isolation (Field installed):

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Rig and install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.

C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Division 26).

E. Controls: Coordinate all control requirements and connections with Controls Contractor.

F. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

END OF SECTION 23 64 25

SECTION 23 65 00 – COOLING TOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes factory assembled and tested, open circuit mechanical induced- draft vertical discharge cooling tower.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, performance curves with selected points indicated, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's prints of equipment assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.

2. Weight and load distribution.

3. Required clearances for maintenance and operation.

4. Sizes and locations of piping and wiring connections.

5. Wiring Diagrams: For power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.

C. Operation and Maintenance Data: Each unit to include operation and maintenance manual.

1.4 QUALITY ASSURANCE

A. Verification of Performance:

A. The thermal performance shall be certified by the Cooling Technology Institute in accordance with CTI Certification Standard STD-201. Lacking such certification, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105, by a Licensed CTI Thermal Testing Agency.

B. Unit Sound Performance ratings shall be tested according to CTI ATC-128 standard. Sound ratings shall not exceed specified ratings.

C. Unit shall meet or exceed energy efficiency per ASHRAE 90.1-2019.

1.5 WARRANTY

A. Submit a written warranty executed by the manufacturer, agreeing to repair or replace components of the unit that fail in materials and workmanship within the specified warranty period.

A. The Entire Unit shall have a comprehensive five (5) year warranty against defects in materials and workmanship from date of shipment.

B. Fan Motor/Drive System: Warranty Period shall be Five (5) years from date of unit shipment from Factory (fan motor(s), fan(s), fan shaft(s), bearings, mechanical support, sheaves, bushings and belt(s)).

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide cooling towers manufactured by one of the following:

1. EVAPCO Model AT 28-4J17T

2. Approved Substitute

2.2 THERMAL PERFORMANCE

A. Each unit shall be capable to cool 900.0 GPM of water entering at 93.0° F leaving at 83.0° F at a design entering wet bulb of 79.0° F.

2.3 IBC COMPLIANCE

A. The structure of this product shall be designed, analyzed, and constructed in accordance with the wind and seismic load requirements of the following: 2009 IBC, 2012 IBC, 2015 IBC, 2018 IBC, ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, NFPA 5000. For Importance Factor (IP) = 1.0, SDS = 1.34 (@ z/h = 0) and P = 119 psf.

2.4 COMPONENTS

1. Description: Factory assembled and tested, induced draft counter flow cooling tower complete with fan, fill, louvers, accessories and rigging supports

2. Materials of Construction

1. All cold water basin components including vertical supports, air inlet louver frames and panels up to rigging seam shall be constructed of Type 304 Stainless Steel. All factory cold water basin seams shall be welded for water tight construction.

2. Casing and fan section, including channels and angle supports, shall be constructed of Type 304 stainless steel. Fan cowl and guard shall be constructed of Type 304 Stainless Steel. "Series 300" stainless steel will not be acceptable as equivalent to Type 304 Stainless Steel.

3. Fan(s):

1. Unit shall be provided with Super Low Sound Fan(s). Fan(s) shall be high efficiency axial propeller type with non-corrosive Fiber Reinforced Polyester (FRP) blade construction. Fan(s) shall be heavy duty and utilize a forward swept blade design for superior sound reduction. Each fan shall be dynamically balanced and installed in a closely fitted fan cowl with venturi air inlet for maximum fan efficiency.

4. Drift Eliminators

1. Drift eliminators shall be constructed entirely of Polyvinyl Chloride (PVC) in easily handled sections. Design shall incorporate three changes in air direction and limit the water carryover to a maximum of 0.001% of the recirculating water rate. Drift eliminators shall be self-extinguishing, have a flame spread of less than 25 under ASTM E84, and shall be resistant to rot, decay and biological attack.

5. Water Distribution System

1. Spray nozzles shall be precision molded ABS, large orifice nozzles utilizing fluidic technology for superior water distribution over the fill media. Nozzles shall be designed to minimize water distribution system maintenance. Spray header and branches shall be Schedule 40 Polyvinyl Chloride (PVC) for corrosion resistance with a steel connection to attach external piping.

6. Heat Transfer Media

1. Fill media shall be constructed of Polyvinyl Chloride (PVC) of cross-fluted design and suitable for inlet water temperatures up to 130° F. The bonded block fill shall be bottom supported and suitable as an internal working platform. Fill shall be self-extinguishing, have a flame spread of less than 25 under ASTM E84, and shall be resistant to rot, decay and biological attack.

7. Air Inlet Louvers

1. The air inlet louvers shall be constructed from UV inhibited Polyvinyl Chloride (PVC) and incorporate a framed interlocking design that allows for easy removal of air inlet louvers for access to the entire basin area for maintenance. The air inlet louvers shall have a minimum of two changes in air direction and shall be of a non-planar design to prevent splash-out and block direct sunlight & debris from entering the basin. Air inlet louvers shall be self-extinguishing, have a flame spread of less than 25 under ASTM E84, and shall be resistant to rot, decay and biological attack.

8. Electronic Water Level Control

1. Electronic water level control package shall have five (5) stainless steel water level sensors (one (1) high level, one (1) high level alarm, one (1) low level, one (1) low level alarm and one (1) ground) with a NEMA 4x enclosure mounted in a cleanable Schedule 40 PVC external standpipe with slow closing solenoid valve(s) and "y" strainer(s). Wiring is not included and components must be field mounted. Valves shall be sized for 25 psi minimum to 125 psi maximum pressure. Standpipe may require heat tracing by others in cold weather applications.

I. Pan Strainer

1. Pan Strainer(s) shall be all Type 304 Stainless Steel construction with large area removable perforated screens.

J. Pipe Connection Type

1. Any connections provided with a Groove (GVD) or Beveled for Welding/Grooved (BFW/GVD) shall conform to standard groove specification (SGS).

2.5 MOTORS AND DRIVES

1. General requirements for motors are specified in Division 23 Section "Motors"

2. Fan Motor

1. Fan motor(s) shall be totally enclosed, ball bearing type electric motor(s) suitable for moist air service. Motor(s) are Premium Efficient, Class F insulated, 1.15 service factor design. Inverter rated per NEMA MG1 Part 31.4.4.2 and suitable for variable torque applications and constant torque speed range with properly sized and adjusted variable frequency drives.

2. Fan motor(s) shall include strip-type space heaters with separate leads brought to the motor conduit box.

3. Fan Drive

1. The fan drive shall be multigroove, solid back V-belt type with QD tapered bushings designed for 150% of the motor nameplate power. The belt material shall be neoprene reinforced with polyester cord and specifically designed for evaporative equipment service. Fan sheave shall be aluminum alloy construction. Belt adjustment shall be accomplished from the exterior of the unit.

4. Fan Shaft

1. Fan shaft shall be solid, ground and polished steel. Exposed surface shall be coated with rust preventative.

5. Fan Shaft Bearings

1. Fan Shaft Bearings shall be heavy-duty, self-aligning ball type bearings with extended lubrication lines to grease fittings located on access door frame. Bearings shall be designed for a minimum L-10 life of 100,000 hours.

6. Vibration Switch

1. Unit shall be provided with a Vibration Cutout Switch, operating on 125 VAC feed, to protect the fan and drive assembly from damage in the event of excess vibration. Vibration switch shall be DPDT.

2.6 MAINTENANCE ACCESS

1. Fan Section

1. Access door shall be hinged and located in the fan section for fan drive and water distribution system access. Swing away motor cover shall be hinged for motor access.

2. Basin Section

1. Framed removable louver panels shall be on all four (4) sides of the unit for pan and sump access.

3. Internal Working Platform

1. Internal working platform shall provide easy access to the fans, belts, motors, sheaves, bearings, all mechanical equipment and complete water distribution system. The fill shall be an acceptable means of accessing these components.

4. External Service Platform with Ladder

1. An external service platform compliant with OSHA shall be provided at the motor access door of the unit extending the full length of the access door. Each platform shall have at least a 36 in walking surface. The platforms shall have galvanized steel grating, supported by galvanized steel framework attached to the unit and surrounded by a handrail, knee rail and toe plate system that is compliant with OSHA. Mounting channels shall be the same material as the casing section (galvanized or stainless steel). A vertical ladder shall be provided from the base of the unit to the platform.

2. Safety cage(s) shall be provided on all vertical ladder(s) and ship mounted. Safety cage(s) shall begin between 7 feet (minimum) and 8 feet (maximum) above grade.

5. Motor Davit with Base

1. Unit shall be provided with mechanical external motor davit assembly which facilitates in removal of larger fan section components. Davit arm shall be constructed of aluminum and base shall be galvanized steel.

2.7 ACCESSORIES

1. Basin Heater Package

1. Cold water basin shall be fitted with copper element, electric immersion heater(s) with a separate thermostat and low water protection device. Heaters shall be selected to maintain +40° F pan water at -20 °F ambient temperature.

2. Electric immersion heater package shall include a factory-supplied NEMA 4x enclosure containing a magnetic contactor with 125 VAC control circuit, transformer, and main power disconnect. Control package wired by others.

2. Sump Sweeper Piping

1. Cold water basin shall be fitted with schedule 80 PVC sump sweeper piping complete with high-flow eductor nozzles to facilitate basin cleaning. The system shall contain one inlet connection and one outlet connection per basin.

END OF SECTION 23 65 00

SECTION 23 74 33 – DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK:

C. Extent of water source Heat Pump work required by this section is indicated on drawings and schedules, and by requirements of this section.

D. Refer to other sections for piping, specialties, pumps, valves, ductwork and balancing which are required external to water source Heat Pump for installation; not work of this section.

E. Refer to other sections for field-installed automatic temperature controls required in conjunction with water source Heat Pump; not work of this section.

F. Electrical Work: Refer to section "Electrical Provisions of Mechanical Work" for requirements. Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 26:

1. Low voltage control wiring between Heat Pump units and remote mounted thermostats and controls.
2. Provide factory-mounted and factory-wired controls and electrical devices as specified in this section.

G. Refer to Division-26 sections for other electrical wiring including motor starters, disconnects, wires/cables, raceways, and other required electrical devices; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of water source heat pumps, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ARI Compliance: The performance standard AHRI/ASHRAE/ISO 13256-1 replaces AHRI Standards 320, 325, and 330. This new standard has three major categories: Water Loop (comparable to ARI 320), Ground Water (ARI 325), and Ground Loop (ARI 330). Although these standards are similar there are some differences: ASHRAE Compliance: Design, construct, and assemble refrigerating system in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
2. ASHRAE 90.1 Compliance: Provide water source heat pumps with not less than minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design".
3. UL Compliance: Design, construct, and assemble water source heat pumps for use with duct systems so as to meet the safety requirements of UL Standard 559 "Heat Pumps".
4. UL Compliance: Design, construct, and assemble free-delivery water source heat pumps so as to meet the safety requirements of UL Standard 484 "Room Air Conditioners".
5. UL Labels: Provide water source heat pumps that are UL listed and labeled.
6. NEC Compliance: Install water source heat pumps in accordance with NFPA 70 "National Electrical Code".

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data including rated capacities of selected model clearly indicated; operating weights; furnished specialties and accessories; and installation, rigging, and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to water- source heat pumps. Submit manufacturer's point-to-point-type wiring diagrams for interlock and control wiring required for final installation of water source heat pumps and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts list for each water source heat pump, control, and accessory; including "trouble- shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Handle water source heat pumps and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged water source heat pumps or components; repair per factory guidelines or replace with new.

B. Store water source heat pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading water source heat pumps and moving units to final location for installation.

1.6 WARRANTY:

Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only and does not include labor for removal and reinstallation.

Standard Warranty Period: All Parts: 1 year from startup or 18 months from ship date

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering water- source heat pumps which may be incorporated in the work include, but are not limited to the following: Manufacturers: Subject to compliance with requirements, provide water source heat pumps of one of the following: WaterFurnace International

2.2 GENERAL

Furnish and install WaterFurnace Water Source Heat Pumps as indicated on the plans. Equipment shall be completely assembled, piped, and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow. The reverse cycle heating/cooling units shall be either suspended type with horizontal air inlet and discharge or floor mounted type with horizontal air inlet and vertical upflow air discharge. Units shall be AHRI/ ISO 13256-1 certified and listed by a nationally recognized safety-testing laboratory or agency, such as ETL Testing Laboratory. Each unit shall be computer run-tested at the factory with con-

ditioned water and operation verified to catalog data. Each unit shall be mounted on a wooden pallet and shipped in a corrugated box or stretch-wrapped. The units shall be designed to operate with entering liquid temperature between 20°F and 120°F [-6.7°C and 48.9°C]

2.3 CASING AND CABINET

A. The cabinet shall be fabricated from heavy-gauge galvanized steel This corrosion protection system shall meet the stringent 1,000-hour salt spray test per ASTM B117. The interior shall be insulated with 1/2 in. thick, multi-density, cleanable aluminum foil coated glass fiber with edges sealed or tucked under flanges to prevent the introduction of glass fibers into the discharge air. Standard cabinet panel insulation must meet NFPA 90.1 requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21 and shall meet zero level bacteria growth per ASTM G22. Unit insulation must meet these stringent requirements or unit(s) will not be accepted.

B. One (horizontal) to two (vertical) blower and two compressor compartment access panels shall be 'lift-out' removable with supply and return ductwork in place.

C. A duct collar shall be provided on the supply air opening. Standard size 1 in. [2.54 cm] MERV 4 filters shall be provided with each unit. Units shall have a return air filter rack that is field convertible from 1 in. [2.54 cm] to 2 in. [5.1 cm]. The upflow vertical units shall have a removable insulated divider panel between the air handling section and the compressor section to minimize the transmission of compressor noise and to permit operational service testing without air bypass. Vertical units shall be supplied with left or right horizontal air inlet and top vertical air discharge. Horizontal units shall be supplied with left or right air inlet and side or end air discharge.

   The compressor shall be double isolation mounted using selected durometer grommets to provide vibration free compressor mounting. The compressor mounting bracket shall be acoustically deadened galvanized steel to prevent vibration transmission to the cabinet.

2.4 REFRIGERATION CIRCUITS

A. All units shall utilize the non-ozone depleting and low global warming potential refrigerant R-454B. All units shall contain a sealed refrigerant circuit including a hermetic motor-compressor, bidirectional thermostatic expansion valve, finned tube air-to-refrigerant heat exchanger, reversing valve, coaxial tube water-to-refrigerant heat exchanger, optional hot water generator coil, and service ports.

B. Compressors shall be high-efficiency variable speed scroll type with brushless permanent magnet motor designed for heat pump duty operation and being capable of modulating down to 25% of capacity. The AC inverter drive shall be capable of providing superheat envelope control and monitor operation with complete diagnostics. The compressor shall be double isolation mounted using selected durometer grommets to provide vibration free compressor mounting.

C. The coaxial water-to-refrigerant heat exchanger shall be designed for low water pressure drop and constructed of a convoluted copper inner tube and a steel outer tube. Heat exchanger shall be rated to withstand 600 psig (4135 kPa) working refrigerant pressure and 450 psig (3101 kPa) working water pressure.

D. Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled aluminum tube construction rated to withstand 600 psig (4135 kPa) refrigerant working pressure.

E. The electronic expansion valve shall provide proper superheat over the entire liquid temperature range with minimal "hunting." The valve shall operate bidirectionally without the use of check valves.

F. A refrigerant detection system is included in units with a refrigerant charge exceeding 64 ounces, in accordance with UL 60335-2-40. This standard requires detection and safety measures for systems containing higher amounts of refrigerant, particularly when flammable refrigerants are used, to ensure occupant safety and compliance with applicable safety regulations.

G. Additional options
   a. Modulating Hot Gas Reheat available to allow dehumidification-only operation. The internal reheat system shall be factory installed and include a high efficiency re-heat coil located downstream of the evaporator coil.

2.5 BLOWER MOTOR AND ASSEMBLY

A. The blower shall be a direct drive centrifugal type with a dynamically balanced wheel. The housing and wheel shall be designed for quiet low outlet velocity operation. The blower housing shall be removable from the unit without disconnecting the supply air ductwork for servicing of the blower motor. The blower motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermostatic overload protection.
   1. Variable speed ECM blower motor shall be a variable speed ECM type. The variable speed ECM blower motor shall be soft starting, shall maintain constant cfm over its operating static range, and shall provide 12 cfm settings. Variable speed ECM motors shall be long-life ball bearing type.

2.6 ELECTRICAL

A. A control box shall be located within the unit compressor compartment and shall contain a 75VA transformer, 24 volt activated, 2 pole compressor contactor, terminal connector for communicating thermostat wiring and solid-state controller for complete unit operation. Electromechanical operation WILL NOT be accepted. Units shall be name-plated for use with time delay fuses or HACR circuit breakers.

B. Electronic Controls
   1. The Advanced Aurora Controls system consists of an Aurora microprocessor-based controller with expansion board that interfaces with an electronic communication thermostat to monitor and control unit operation. The control shall provide operational sequencing, compressor, and blower speed control, high and low-pressure switch monitoring, advanced freeze detection, electronic condensate overflow sensing, lockout mode control, LED status and fault indicators, fault memory, field selectable options and accessory output. The control shall provide fault retry three times before locking out to limit nuisance trips.

A detachable terminal block with screw terminals will be provided for field control wiring. All units shall have knockouts for entrance of low and line voltage wiring. The blower motor and control box shall be harness plug wired for easy removal.

a. Option: Advanced Aurora W/DDC shall be included that communicates directly with the Aurora Heat Pump Controls and allows access/control of a variety of internal Aurora heat pump operations such as sensors, relay operation, faults, and other information. The UPC shall convert the internal Aurora Modbus protocol to BACnet MS/TP, or N2 protocols for communication over a BAS system. Additional individual unit data such as enumerated fault codes, refrigerant, performance, and energy monitoring, ECM fan speeds, and control board configuration settings shall be directly available over the BAS without the need for access to the heat pump.
b. For VAV and Leaving Air Temperature Applications, contact the Local Water-Furnace Commercial Representative.

2.7 PIPING

A. Supply and return water connections shall be FPT copper fittings fixed to the bottom panel, which eliminates the need for backup pipe wrenches.

2.8 CONDENSATE AND DRAIN PAN

A. With vertical units, the condensate connection shall be a 3/4 in. [19.1 mm] PVC socket with internally trapped hose that can be routed to front or side corner post locations.
B. On horizontal units, a Stub is provided for condensate drain piping connection. An external trap is required. If a vent is necessary, an open standpipe may be applied to a Tee in the field installed condensate piping.
C. Condensate drain pan: Bacteria resistant composite drain pan is sloped to promote complete drainage and will never rust or corrode. Complete drainage helps to inhibit bacterial or microbial growth. Vertical units feature an internally trapped condensate line using clear PVC hose for easy inspection and reduced installation cost.

3.0 ACCESSORIES

A. Thermostat (factory furnished and field installed)
A communicating auto-changeover electronic thermostat shall be provided. The thermostat shall offer variable speed heating and cooling staging with precise temperature control. An OFF-HEAT-AUTO-COOL-EMERG system switch, OFF-AUTO-INTERMITTENT blower switch, and indicating display shall be provided. The thermostat shall display in °F or °C. The thermostat shall provide real time energy consumption data of the unit.

B. Color Touchscreen Thermostat (factory furnished and field installed)
A color touchscreen communicating auto-changeover electronic thermostat shall be provided. The thermostat shall offer variable speed heating and cooling staging with precise temperature control. An OFFHEAT-AUTO-COOL-EMERG system switch, OFF-AUTOINTERMITTENT blower switch, and indicating display shall be provided. The thermostat shall display in °F or °C. The thermostat shall provide real time and historical energy consumption data of the unit

C. Modulating 2-Way Water Control Valve: An internally mounted 2-way modulating solenoid valve shall be factory installed and modulated by the Advanced Aurora Controls platform. Modulating percentage range is adjustable through the Aurora and the valve position is tied to compressor speed. This valve can be factory installed or optionally field installed.

D. Hose Kits – Ball Valves (field-installed)
A flexible steel braid hose featuring Kevlar® reinforced EPDM core with ANSI 302/304 stainless steel outer braid and fire rated materials per ASTM E 84-00 (NFPA 255, ANSI/UL 723 & UBC 8-1). Ball valve at one end; swivel connector with adapter at the other end (swivel to adapter connection via fiber or EPDM gasket). Swivel connection provides union between heat pump and piping system. The hoses feature brass fittings, stainless steel ferrules. A full port ball valve shall be provided with integral P/T (pressure/temperature) port on supply hose.

Specifications:

- Temperature range of 35°F [2°C] to 180°F [82°C].
    - Max. working pressure of 400 psi [2757 kPa] for 1/2 in. and 3/4 in. hose kits; Max. working pressure of 350 psi [kPa] for 1 in. and 1-1/4 in. hose kits.

E. Hose Kits – Automatic Balancing and Ball Valves (field-installed)
A flexible steel braid hose featuring Kevlar® reinforced EPDM core with ANSI 302/304 stainless steel outer braid and fi re rated materials per ASTM E 84-00 (NFPA 255, ANSI/UL 723 & UBC 8-1). Ball valve at one end; swivel connector with adapter at the other end (swivel to adapter connection via fiber or EPDM gasket). Swivel connection provides union between heat pump and piping system. The hoses feature brass fittings, stainless steel ferrules. A full port ball valve shall be provided with integral P/T (pressure/ temperature) port on supply hose and automatic balancing valve with integral P/T ports and full port ball valve on return hose.

Specifications:

- Temperature range of 35°F [2°C] to 180°F [82°C].
- Max. working pressure of 400 psi [2757 kPa] for 1/2 in. and 3/4 in. hose kits; Max. working pressure of 350 psi [kPa] for 1 in. and 1-1/4 in. hose kits.
- Minimum burst pressure of four times working pressure.

F. Hose Kits – Automatic Balancing and Ball Valves with 'Y' strainer (field-installed)
A flexible steel braid hose featuring Kevlar® reinforced EPDM core with ANSI 302/304 stainless steel outer braid and fire rated materials per ASTM E 84-00 (NFPA 255, ANSI/UL 723 & UBC 8-1). Ball valve at one end; swivel connector with adapter at the other end (swivel to adapter connection via fiber or EPDM gasket). Swivel connection provides union between heat pump and piping system. The hoses feature brass fittings, stainless steel ferrules. A "Y" strainer is provided on one end for fluid straining and integral "blowdown" valve. A full port ball valve shall be provided with integral P/T (pressure/temperature) port on supply hose and automatic balancing valve with integral P/T ports and full port ball valve on return hose.

Specifications:

- Temperature range of 35°F [2°C] to 180°F [82°C].
- Max. working pressure of 400 psi [2757 kPa] for 1/2 in. and 3/4 in. hose kits; Max. working pressure of 350 psi [kPa] for 1 in. and 1-1/4 in. hose kits.
- Minimum burst pressure of four times working pressure.

G. Waterside Economizer - use the building's interior loop water to provide "free" cooling. By passing air through a coil cooled by loop water rather than through a coil cooled by mechanical refrigeration. The economizer contains a water-to-air heat exchanger, a 3-way valve, and controls that manage the flow of water through the heat exchanger. The economizer is mounted in line with the heat pump's return air flow. When cooling is required and the building loop water temperature is below the economizer setpoint, typically 45°F, water is passed through the economizer. Air is drawn through the cool economizer and the heat pump's compressor is turned off. Cooling is then provided by the economizer, reducing energy use.

H. Hot Water Pump Kit - An accessory pump kit is available for hot water generation option. This kit includes hot water pump, fittings, and water heater kit necessary for potable water application.

END OF SECTION 23 74 33

SECTION 23 81 26 – DUCTLESS SPLIT-SYSTEM UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 SUBMITTALS

A. Product Data:

1. Evaporator-fan components.
2. Condensing unit components.
3. Refrigeration piping line set.
4. System controls.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. Applicable requirements in ASHRAE 62.1-2007, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Compressor: Five year(s) from date of Substantial Completion.
2. Other Parts: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. LG

2.2 GENERAL

A. Description:
1. Outdoor--mounted, air--cooled, split--system air conditioner unit suitable for ground or rooftop installation. Unit consists of a hermetic compressor, an air--cooled coil, propeller—type condenser fan, and a control box. Unit will discharge supply air horizontally as shown on contract drawings. Unit will be used in a refrigeration circuit to match up to a packaged fan coil or coil unit.
2. Indoor, direct--expansion, wall--mounted fan coil. Unit shall be complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

B. Refrigeration Components:
1. Refrigeration circuit components will include liquid--line front--seating shutoff valve with sweat connections, vapor--line front--seating shutoff valve with sweat connections, system charge of R--410A refrigerant, and compressor oil. Unit will be equipped with high--pressure switch, low pressure switch and filter drier for R-410A refrigerant.

2.3 WALL MOUNT DUCTLESS INDOOR UNITS

A. General: Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.

B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal / acoustic performance.

C. Fans:
1. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
2. Air sweep operation shall be useable selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction maybe be set manually.

D. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall

have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.

E. Motors: Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3- speed.

F. Controls: Controls shall consist of a microprocessor- based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 62°F to 86°F in increments of 1°F, and have 46°F Heating Mode (Heating Setback). The wireless remote controller shall have the ability to act as the temperature sensing location for room comfort.

G. The unit shall have the following functions as a minimum:
   1. An automatic restart after power failure at the same operating conditions as at failure.
   2. A timer function to provide a minimum 24- hour timer cycle for system Auto Start/Stop.
   3. Temperature- sensing controls shall sense return air temperature.
   4. Indoor coil freeze protection.
   5. Wireless infrared remote control to enter set points and operating conditions.
   6. Automatic air sweep control to provide on or off activation of air sweep louvers.
   7. Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
   8. Fan- only operation to provide room air circulation when no cooling is required.
   9. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
   10. Fan speed control shall be user- selectable: turbo, high, medium, low, or microprocessor controlled automatic operation during all operating modes.
   11. Automatic heating- to- cooling changeover in heat pump mode. Control shall include deadband to prevent rapid mode cycling between heating and cooling.
   12. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

H. Filters: Units shall have filter track with factory-supplied cleanable filters.

I. Electrical Requirements: Indoor fan motor to operate on 208- 230V. Power is supplied from the outdoor unit.

J. Operating Characteristics: The system shall have a minimum SEER (Seasonal Energy Efficiency Ratio) and HSPF at AHRI conditions, as listed on the specifications table.

K. Refrigerant Lines: All units should have refrigerant lines that can be oriented to connect from the left, right or back of unit. Both refrigerant lines need to be insulated.

L. Condensate Pump: The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound- shielded pump assembly. A liquid level sensor in the reservoir shall stop cooling operation if the liquid level in the reservoir is unacceptable.

2.4 OUTDOOR UNITS

A. General: Factory assembled, single piece, air-cooled outdoor unit. Contained within the enclosure shall be all factory wiring, piping, controls, and compressor.

B. Unit Cabinet:
1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with baked-enamel finish on inside and outside.
2. Unit access panel should be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

C. Fans:
1. Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fan shall draw air through the outdoor coil.
2. Outdoor fan motors shall be multi- speed, totally-enclosed, single phase motors with permanently lubricated ball bearings. Motor shall be protected by internal thermal overload protection.
3. Shaft shall have inherent corrosion resistance.
4. Outdoor fan openings shall be equipped with metal/mesh PVC coated protection grille over fan.

D. Compressor:
1. Compressor shall be fully hermetic variable speed rotary type.
2. Compressor shall be single phase, inverter driven.
3. Compressor shall be equipped with oil system, operating oil charge, and motor.
4. Motor shall be suitable for operation in refrigerant and oil atmosphere.
5. Compressor assembly shall be installed on rubber vibration isolators.
6. The inverter and compressor shall be protected against over temperature and over current.

E. Outdoor Coil: Coil shall be constructed of Aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated and sealed.

F. Refrigerant Components: Refrigerant circuit components shall include multiple brass external liquid line service valves with service gauge connection port, multiple suction line service valves with service gage connection port, accumulator, reversing valve, electronic expansion valves.

G. Safeties: Operating safeties shall be factory selected, assembled, and tested. The minimum functions shall include the following:
1. Compressor discharge over temperature protection.
2. System low voltage protection.
3. Compressor overload protection.
4. Compressor over current protection.
5. IPM module protection.

H. Electrical Requirements:
1. Units shall operate on single-phase, 60 Hz power at 208/230 v.
2. Unit electrical power shall be a single point connection.

3. All power and control wiring must be installed per NEC and all local electrical codes.
4. Units shall have multiple terminal blocks to connect to multiple indoor units.

2.5 ACCESSORIES

A. Thermostat: Low-voltage, Remote Wired Controller.

B. Remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate.

F. Condensing unit wall mounting brackets.

G. Low ambient cooling to -13°F.

H. Refrigerant line covers.

I. Hail guards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install compressor-condenser components on angle iron frame securely attached to building wall.

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

E. Install interlock wiring between evaporator and compressor units.

F. Refer to drawings for condenser roof mounting detail.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts" Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 81 46 – WATER SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fluid to air extended range units.

1.2 RELATED SECTIONS

A. Refer to Division 16 for electrical power wiring requirements from the source to the power connection on the water source heat pump units. Information to be referenced include: electrical characteristics, circuit protection, wiring and unit connection methods.

B. Section 23XXX – Gauges and Meters: Test Plugs, Pressure Gauges, Thermometers

C. Section 23XXX – Mechanical Identification: Nameplates, Tags.

D. Section 23XXX – Vibration Isolation: Neoprene Pad Isolators.

E. Section 23XXX

2

F. – Hydronic Specialties: Water Strainers, Air Vents, Glycol Specialties.

2.1 CODES AND STANDARDS

A. NFPA 70 – National Electrical Code.

B. UL Listing and Compliance – Units are to be designed, constructed, and assembled to meet or exceed all applicable Underwriters' Laboratories safety requirements. Units must be listed and labeled as having met UL safety standards.

C. ASHRAE 90.1 – "Energy Conservation in New Building Design".

D. ARI/ASHRAE/ISO Standard 13256-1 – Ground-Loop Heat Pump.

2.2 SUBMITTALS FOR REVIEW

A. Section 013XX – Submittals: Procedures for submittals.

B. Submit manufacturer's technical product data including:

1. ARI certified heating and cooling capacities at ISO 13256-1 conditions.

2. Electrical power input and ARI certified unit efficiency at ISO 13256-1 conditions.

3. Water pressure drop through unit and furnished unit hydronic specialties at specified flow rates.

2.3 SUBMITTALS FOR INFORMATION

A. Section 013XX – Submittals: Procedures for submittals.

B. Submit manufacturer's technical product data including:

1. Detailed dimensional drawings – provide unit drawings from manufacturer that indicate all necessary dimensional data including: overall unit size and operating weight, unit service access panels and required clearances, ductwork connections, electrical, and plumbing connections.
2. Complete unit electrical data including: rated operating voltage, total unit full load amperage, minimum circuit amperage, maximum fuse/HACR breaker size and wiring diagrams. Wiring diagrams should clearly differentiate between the portions of the wiring that are factory-installed and portions that are field-installed.
3. Furnished system specialties and accessories.
4. Installation instructions – indicating assembly, support details, connection requirements, and system start-up instructions.

2.4 SUBMITTALS FOR CLOSEOUT

A. Section 017XX – Contract Closeout: Procedures for submittals.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and trouble-shooting guides, and repair data including common
repair parts.

C. Provide a detailed equipment schedule that includes: unit model and serial numbers, unit
tag or identification, location, and air filter quantity and sizes.

2.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years' experience.

2.6 DELIVER, STORAGE, AND PROTECTION

A. Section XXXXX – Material and Equipment: Transport, handle, store, and protect products.

B. Thoroughly inspect units at the time of delivery making note of any discrepancies or irregularities on the delivery documentation. Comply with manufacturer's rigging and

installation instructions for unloading units and moving to final location for installation.

C. Protect finished cabinets from physical damage by leaving factory packing in place
3 until installation and providing temporary covers after installation if the units are to be

exposed to potential damage. Do not install damaged water source heat pumps or components; repair per factory guidelines or replace with new.

3.1 WARRANTY

A. Section XXXXX – Contract Closeout.

B. Provide a five (5) year warranty to include coverage for the following components: compressor, refrigerant to water heat exchanger, refrigerant to air heat exchanger, thermal expansion valve, reversing valve, and microprocessor-based controls. Provide a one (1) year warranty on all other components. Warranty is limited to component replacement only and does not include labor for removal and reinstallation.

4

5 Standard Warranty Period: All Parts: 1 year from startup or 18 months from ship date

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering water- source heat pumps which may be incorporated in the work include, but are not limited to the following: Manufacturers: Subject to compliance with requirements, provide water source heat pumps of one of the following: Water-Furnace International

B. Section XXXXX – Materials and Equipment: Product options, Substitutions.

2.2 FLUID TO AIR EXTENDED RANGE UNITS

A. Description: Factory assembled and tested, single packaged water source heat pump consisting of a heavy gauge, galvanized steel cabinet with powder coat paint, sealed refrigerant circuit including a compressor, coaxial refrigerant to water heat exchanger, refrigerant to air heat exchanger, bi-directional thermal expansion valve, reversing valve, and reverse cycle refrigeration controls. The unit and all refrigeration components shall be rated for use with R-454B refrigerant. Field conversion of refrigerants will not be allowed.

B. Cabinet: Heavy gauge G-60 galvanized steel cabinet with a corrosion-resistant powder coating. The interior shall be insulated with ½" thick, multi-density, aluminum foil coated glass fiber with edges sealed or tucked under flanges to prevent the introduction of glass fibers into the discharge air. An insulated divider panel shall separate the fan section from the compressor compartment. Removable service panels shall be provided to permit access to the compressor compartment, control box and fan section. The cabinet shall have separate knockouts for the entrance of line voltage and low voltage control wiring.

C. Refrigerant to Water Heat Exchanger: Coaxial type heat exchanger consisting of a

copper inner tube and a steel outer tube capable of withstanding 650 psig working pressure on the refrigerant side and 450 psig on the water side. The inner tube shall be a convoluted design and bead blasted to optimize heat transfer. The heat exchanger shall be insulated to prevent condensation from forming on the outer tube walls.

D. Refrigerant to Air Heat Exchanger: Multiple row copper tube with enhanced aluminum fin heat exchanger design capable of withstanding 650 psig working pressure.
6 The condensate drain pan shall be constructed of high-density polyethylene to inhibit corrosion and bacterial growth. optional secondary drain connection.

E. Compressor: Provide hermetic, high efficiency, scroll or rotary type compressor installed on neoprene isolators and double isolated using an acoustically treated mounting bracket. A factory installed sound attenuating treatment shall be applied to the compressor. Provide high and low temperature cutouts, and compressor motor overload protection. Provide capability to reset compressor lockout circuit at either remote thermostat or circuit breaker.

F. The unit shall have a direct drive fan assembly with a dynamically balanced blower wheel. The fan motor shall be isolated from the blower housing by rubber grommets.

G. Refrigeration Components: Provide 4-way, electro-magnetically activated solenoid refrigerant reversing valve designed for fail-safe operation in the heating position. The solenoid coil assembly must be detachable from valve body. Provide a bi-directional, thermostatic expansion valve to deliver proper superheat over the complete range of operating water temperatures. Provide a liquid line filter dryer within the refrigerant circuit to maintain system integrity.

H. Water Piping Connections: The unit shall have standard female NPT connections flush mounted to the cabinet exterior and shall incorporate an integral back-plate to secure the fitting without the need of a back-up wrench.

I. A refrigerant detection system is included in units with a refrigerant charge exceeding 64 ounces, in accordance with UL 60335-2-40. This standard requires detection and safety measures for systems containing higher amounts of refrigerant, particularly when flammable refrigerants are used, to ensure occupant safety and compliance with applicable safety regulations.

7

8 Air filter Provide 1" MERV 4 pleated fiberglass included with filter rail, field switchable for 1 in. or 2 in. filters

J. Unit Controls:
1. Provide factory-mounted and factory-wired controls for sequenced operation of compressor, blower, reversing valve and system accessories. A 24-volt, minimum 75VA transformer with integral circuit breaker shall provide power to the low voltage controls. Provide safety lockout control with refrigerant high-pressure switch, refrigerant low-pressure or loss of charge switch, and water freeze protection. The lockout circuit shall be capable of being reset by either resetting the low voltage power supply or the main unit circuit breaker.
2. Microprocessor Control
3. Coordinate all temperature control work with the BAS Control Manufacturer, Section 239XX.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install extended range water source heat pumps in accordance with manufacturer's written instructions.

B. Install units with adequate clearance from obstructions to allow for servicing and filter replacement.

C. Coordinate installation of units with work being performed by other trades or contractors.

3.2 CONNECTIONS

A. Ground Loop Water Piping: Connect supply and return piping to heat pump as indicated, with unions and shutoff valves. All unit supply and return piping is to be insulated. Provide Field installed water strainers to prevent particulate debris from obstructing water flow through the water to refrigerant heat exchangers.

B. Electrical: Install all electrical devices furnished, but not specified to be factory mounted. Verify that unit is properly grounded and that wiring connections are in accordance with manufacturer's written documentation.

3.2 FIELD QUALITY CONTROL

A. General: Start-up heat pump units in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements with Project Manager on site to witness test. Replace damaged or malfunctioning controls and equipment.

3.3 DEMONSTRATION

A. Provide the services of a factory-authorized representative for one day to instruct the Owner's personnel as specified:

1. Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
2. Review data in the maintenance manuals specified in Section 1.6.
3. Schedule training with Owner, through Project Manager, with at least 7 days' advance notice.

END OF SECTION 23 81 46

SECTION 23 82 19 - FAN COIL UNITS

GENERAL
Furnish and install ENVIRO-TEC® Model HL Horizontal Direct Drive Fan Coil Units where indicated on the plans and in the specifications. Units shall be completely factory assembled, tested and shipped as one piece. Units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. Unit dimensions for each model and size shall be considered maximums. Units shall be cETLus listed in compliance with UL/ANSI Standard UL60335, and be certified as complying with the latest edition of AHRI Standard 440. Unit shall be produced in a facility found to conform to the Quality Management System standard: ISO 9001:2015.

CONSTRUCTION
Unit chassis shall be fabricated of galvanized steel panels. Exterior panels shall be insulated with 3/8" thick elastomeric closed cell foam Insulation. Insulation shall conform to UL 181 for erosion and NFPA 90A for fire and smoke, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. Polyethylene insulation is not acceptable. Ducted units shall have a minimum 1-1/2" duct collar on the discharge. Plenum and exposed units shall have a minimum 3/4" duct collar on the return. Exposed units shall have exterior panels fabricated of galvannealed steel. The fan and filter bottom access panel shall be attached with quarter turn quick open fasteners to allow for easy removal and access for service. Unit mounting shall be by hanger brackets provided at four locations.

PAINTED FINISH
Painted cabinet exterior panels shall be finished with a heat cured anodic acrylic powder paint of the standard factory color.

SOUND
Ducted units shall have published sound power level data tested in accordance with AHRI Standard 260-2012. Exposed units shall have published sound power level data tested in accordance with AHRI Standard 350-2015 (non-ducted equipment).

FAN ASSEMBLY
Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. Motors shall be high efficiency, permanently lubricated sleeve bearing, permanent split-capacitor type with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps. Single speed motors are not acceptable. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. The entire fan assembly shall be able to come out of the unit by removing two screws and unplugging the motor. Plenum unit fan assemblies shall be easily serviced through an access panel in casing. Devices used to energize and de-energize (switch) fan speeds must be silent. Magnetic, mercury, and/or quiet relays and/or contactors are not acceptable.

Motor shall be capable of accepting a 2-10 VDC output from BAS.

COILS
All cooling and heating coils shall optimize rows and fins per inch to meet the specified capacity. Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin. Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.

Each coil shall be pressured to 450 PSIG and rated for a maximum of 450 PSIG working pressure.

Steam coils shall be standard steam type suitable for temperatures above 35°F and 15 PSIG maximum working pressure.

Heating coils shall be furnished in the reheat position on units with chilled water coils.

DRAIN PANS
Primary condensate drain pans shall be single wall, heavy gauge galvanized steel for corrosion resistance, and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be double sloped for condensate removal. Drain pans shall be fully removable without the use of any tools. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.

Provide a single wall primary drain pan constructed entirely of heavy gauge stainless steel for superior corrosion resistance. Stainless steel drain pans shall be externally insulated.

FILTERS
All plenum and exposed units shall be furnished with 1" pleated filter (MERV 8). Filters shall be tight fitting to prevent air bypass. Plenum unit filters shall be easily removable from the bottom of the unit without the need for tools.

ELECTRICAL
Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations.

END OF SECTION 23 82 19

SECTION 23 82 39 – UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by any nationally recognized testing laboratory (NRTL) recognized under 29 CFR 1910.7.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - Systems and Equipment; and Section 7 - Construction and Startup.

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - Heating, Ventilating, and Air-Conditioning.

D. Gas-Fired Unit Heater Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.8.

1.6 WARRANTY

A. Furnish 5-year manufacturer warranty.

PART 2 - PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products indicated on Drawings or a comparable product by one of the following:

A. QMark Electric Heating

B. Modine.

C. Sterling.

2.2 WALL AND CEILING ELECTRIC UNIT HEATERS

A. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Cabinet:

1. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

E. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated. Comply with requirements in Section 26 0700 Induction Motors-500HP and Smaller.

F. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

G. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

H. Capacities and Characteristics: See Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit heaters to comply with NFPA 90A.

B. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54.

C. Suspended Units: Suspend unit heaters from structure with all-thread hanger rods and seismic restraint. Adjust hangers so unit is level and plumb. Hanger rods and attachments to structure are specified in Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment. Vibration isolators are specified in Section 22 0548, Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Gas Piping: Comply with Section 23 1123, Facility Natural-Gas Piping. Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

F. Hot Water Unit Heaters: Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater.

G. Install piping adjacent to machine to allow service and maintenance.

H. Connect piping to unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

I. Ground equipment according to Section 26 0526, Grounding and Bonding for Electrical Systems.

J. Connect wiring according to Section 26 0519, Low-Voltage Electrical Power Conductors and Cables.

K. Adjust initial temperature set points.

L. Adjust burner and other unit components for optimum heating performance and efficiency.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. For units that have electric resistance heating coils, operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 39

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: For sleeve seals.
2. Shop Drawings: For seismic restraints, signed and sealed by a qualified professional engineer.
   a. Design analysis to support selection and arrangement of seismic restraints.
3. Electrical Contractor shall be responsible for providing & installing embedded back boxes & conduit in walls, for in-room temperature sensors/thermostats, up to 12" above ceiling. Electrical Contractor shall refer to Mechanical construction drawings for locations, and shall coordinate with Temperature Controls Contractor.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D
2. Building Seismic Design Category: C
3. Assigned Seismic Risk Category as Defined in the IBC: III.

   a. Component Importance Factor: 1.0. To be determined from ASCE 07-10 section 13.1.1 for each component type
   b. Component Response Modification Factor: 2.5. To be determine from ASCE 07-10 Table 13.6-1 for each component type
   c. Component Amplification Factor: 2.5. To be determine from ASCE 07-10 Table 13.6-1 for each component type

4. Design Spectral Response Acceleration at Short Periods (0.2 Second): 43.3%g.
5. Design Spectral Response Acceleration at 1-Second Period: 23.1%g.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 RACEWAYS

A. Raceways:

1. EMT: ANSI C80.3 and UL 797.
2. ENT: NEMA TC 13 and UL 1653.
3. FMC: UL 1; zinc-coated steel.
4. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
5. GRC: ANSI C80.1 and UL 6, hot-dip galvanized.
6. LFMC: UL 360, zinc-coated, flexible steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
7. RNC: UL 621 and NEMA TC 2, Type EPC-40-PVC, with NEMA TC3 fittings.
8. Raceway Fittings: Specifically designed for raceway type used in Project.

B. Wireways: Sheet metal sized and shaped, with screw covers.

C. Surface Raceways:

1. Metal: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
2. Plastic: PVC, extruded and fabricated to size and shape indicated in color selected, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Handholes and Boxes for Exterior Underground Wiring:

1. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
2. Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."

2.3 CONDUCTORS AND CABLES

A. Conductors:

1. Comply with NEMA WC70.
2. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
3. Conductors, Larger Than No. 10 AWG: Stranded copper.
4. Insulation: Thermoplastic, Type THHN-THWN or XHHW.
5. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.4 GROUNDING MATERIALS

A. Conductors: Solid for No. 8 AWG and smaller, and stranded for No. 6 AWG and larger unless otherwise indicated.

1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
2. Bare, Solid-Copper Conductors: Comply with ASTM B 3.
3. Bare, Stranded-Copper Conductors: Comply with ASTM B 8.

B. Ground Rods: Copper-clad steel, sectional type; 5/8 by 96 inches in diameter.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts with clamp-type pipe connectors sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.5 ELECTRICAL IDENTIFICATION MATERIALS

A. Raceway Identification Materials: Self-adhesive, color-coding vinyl tape; flexible, preprinted, self-adhesive vinyl.

B. Conductor Identification Materials: Color-Coding Conductor Tape: Self-adhesive vinyl tape 1 to 2 inches wide.

C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, polyethylene tape with continuous metallic strip or core.

D. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with circuit identification legend machine printed by thermal transfer or equivalent process.

E. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

F. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.

G. Equipment Identification Labels: Engraved, laminated acrylic or melamine label; punched or drilled for screw mounting. White letters on a dark-gray background; red letters for emergency systems.

H. Fasteners: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.6 SUPPORT AND ANCHORAGE COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly, and provide finish suitable for the environment in which installed.

1. Channel Dimensions: Selected for structural loading and applicable seismic forces.

B. Raceway and Cable Supports: As described in NECA 1.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and fittings.

D. Mounting, Anchoring, and Attachment Components:

1. Powder-Actuated Fasteners: Threaded-steel stud.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete.
3. Concrete Inserts: Steel or malleable-iron, slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, high strength; complying with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.7 SEISMIC-RESTRAINT COMPONENTS

A. Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least four times the maximum seismic forces to which they will be subjected.

B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.

1. Seismic Mountings, Anchors, and Attachments: Devices as specified in "Support and Anchorage Components" Article, selected to resist seismic forces.
2. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
3. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.

4. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

2.8 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized-steel sheet.

D. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining.

PART 3 - EXECUTION

3.1 GENERAL ELECTRICAL EQUIPMENT INSTALLATION REQUIREMENTS

A. Install electrical equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

B. Install electrical equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.

C. Install electrical equipment to allow right of way for piping and conduit installed at required slope.

D. Install electrical equipment to ensure that connecting raceways, cables, wireways, cable trays, and busways are clear of obstructions and of the working and access space of other equipment.

E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Comply with requirements in Section 083113 "Access Doors and Frames."

G. Install sleeve and sleeve seals of type and number required for sealing electrical service penetrations of exterior walls.

H. Comply with NECA 1.

3.2 RACEWAY AND CABLE INSTALLATION

A. Outdoor Raceways Applications:

1. Exposed or Concealed: IMC.
2. Underground, Single Run: RNC.
3. Connection to Vibrating Equipment: LFMC.
4. Boxes and Enclosures: Metallic, NEMA 250, Type 3R or Type 4.

B. Indoor Raceways Applications:

1. Exposed or Concealed: EMT.
2. Connection to Vibrating Equipment: FMC; in wet or damp locations, use LFMC.
3. Damp or Wet Locations: IMC.
4. Boxes and Enclosures: Metallic, NEMA 250, Type 1, unless otherwise indicated.

C. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

E. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch-thick concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Install conduit larger than 1-inch trade size, parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.
4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.

F. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

G. Install pull wires in empty raceways.

H. Connect motors and equipment subject to vibration, noise transmission, or movement with a 72-inch maximum length of flexible conduit.

I. Install raceways and cables conceal within finished walls, ceilings, and floors unless otherwise indicated.

J. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

K. Installation of Hangers and Supports:

1. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in this article.
2. Separate dissimilar metals and metal products from contact with wood or cementitious materials, by painting each metal surface in area of contact with a bituminous coating or by other permanent separation.
3. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
4. Multiple Raceways or Cables: Install on trapeze-type supports fabricated with steel slotted channel.
5. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
6. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods, unless otherwise indicated or required by Code:

    a. To Wood: Fasten with lag screws or through bolts.
    b. To New Concrete: Bolt to concrete inserts.
    c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    d. To Existing Concrete: Expansion anchor fasteners.
    e. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
    f. To Light Steel: Sheet metal screws.
    g. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount on slotted-channel racks attached to substrate.

7. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway

B. Exposed Feeders, Branch Circuits, and Class 1 Control Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders and Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and underground: Type THHN-THWN, single conductors in raceway.

E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.

F. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.4 GROUNDING

A. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum. Bury at least 24 inches below grade.

B. Pipe and Equipment Grounding Conductor Terminations: Bolted.

C. Underground Connections: Welded.

D. Connections to Structural Steel: Bolted.

E. Install grounding conductors routed along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

F. Install ground rods driven into ground until tops are 2 inches below final grade, or 4 inches above, finished floor slab unless otherwise indicated.

G. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape.

H. Make connections without exposing steel or damaging coating if any.

I. Install bonding straps and jumpers in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

J. Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

K. Bond to equipment mounted on vibration isolation hangers and supports so vibration is not transmitted to rigidly mounted equipment.

L. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

M. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.

1. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
2. Perform tests by fall-of-potential method according to IEEE 81.
3. Report measured ground resistances that exceeds 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.5 IDENTIFICATION

A. Power-Circuit Conductor Identification: For No. 3 AWG conductors and larger, at each location where observable, identify phase using color-coding conductor tape.

B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring.

C. Warning Labels for Enclosures for Power and Lighting: Comply with 29 CFR 1910.145; identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

D. Equipment Identification Labels:

1. Labeling Instructions:

   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
   c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

    a. Panelboards, electrical cabinets, and enclosures.
    b. Electrical switchgear and switchboards.
    c. Transformers.
    d. Motor-control centers.
    e. Disconnect switches.
    f. Enclosed circuit breakers.
    g. Motor starters.
    h. Push-button stations.
    i. Power transfer equipment.
    j. Contactors.

E. Verify identity of each item before installing identification products.

F. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

G. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

H. Install system identification color banding for raceways and cables at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

I. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Ungrounded service, feeder and branch-circuit conductors.

1. Colors for 208/120-V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

2. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points.

J. Underground-Line Warning Tape: Continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade.

3.6 SEISMIC REQUIREMENTS

A. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

B. Install bushing assemblies for anchor bolts for wall- and floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in substrate.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

D. Accommodation of Differential Seismic Motion: Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element than the one supporting them as they approach equipment.

3.7 SLEEVE AND SLEEVE-SEALS INSTALLATION

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

B. Cut sleeves to length for mounting flush with both wall surfaces.

C. Extend sleeves installed in floors 2 inches above finished floor level.

D. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

E. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

F. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Section 079200 "Joint Sealants."

G. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

H. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

I. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 26 05 00

SECTION 26 05 19 – LOW-VOLTAGE ELCTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Nonmetallic-sheathed cable.

C. Service entrance cable.

D. Metal-clad cable.

E. Wiring connectors and connections for 600 volts or less.

F. Electrical tape.

G. Heat shrink tubing.

H. Oxide inhibiting compound.

I. Wire pulling lubricant.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

C. Section 28 31 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2001 (Reapproved 2007).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).

E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005.

F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2007.

G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2008.

I. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

J. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; National Electrical Contractors Association; 2006 (NECA/AA 104).

K. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2006.

L. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); National Electrical Contractors Association; 2007.

M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).

N. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

O. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

Q. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

R. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

S. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

T. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

U. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

V. UL 719 - Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.

W. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.

X. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Administrative Requirements for general submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction, and marked for its intended use.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions.

When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

B. Comply with NEMA WC 70 for copper and aluminum conductors including their insulation materials.

C. Comply with NEMA WC 5.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Metal-clad cable is permitted only as follows:

1. Where not otherwise restricted, may be used:
    a. Where concealed in hollow stud walls, above accessible ceilings.
2. In addition to other applicable restrictions, may not be used:
    a. Where exposed to view.
    b. Where exposed to damage.
    c. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

2.2 CONDUCTOR AND CABLE MANUFACTURERS

A. Cerro Wire LLC: www.cerrowire.com.

B. Industrial Wire & Cable, Inc: www.iewc.com.

C. Southwire Company: www.southwire.com.

D. Alcan; Model Stabiloy: www.cable.alcan.com

E. Belden: www.belden.com.

F. General Cable: www.generalcable.com

G. USA Cable: www.USAwire-cable.com

H. AmerCable: www.amercable.com

I. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 ALL CONDUCTORS AND CABLES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:

1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
    a. Substitution of aluminum conductors for copper is permitted, when approved by Owner and authority having jurisdiction, only for the following:
        1) Services: Copper conductors size 3 AWG or larger.
        2) Feeders: Copper conductors size 3 AWG or larger.
    b. Where aluminum conductors are substituted for copper, comply with the following:
        1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
        2) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors.
        3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.
4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

H. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.

a. Exceptions:

1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.

I. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.

a. Conductors size 6 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.

3. Color Code:

a. 208Y/120 V, 3 Phase, 4 Wire System:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral/Grounded: White.

b. Equipment Ground, All Systems: Green.

2.4 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:

1. Copper Building Wire:

a. Cerro Wire LLC: www.cerrowire.com.
b. Encore Wire Corporation: www.encorewire.com.
c. Southwire Company: www.southwire.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Aluminum Building Wire (only where specifically indicated or permitted for substitution):

a. Alcan Products Corporation/Alcan Cable: www.cable.alcan.com.
b. Prysmian Power Cables and Systems: www.us.prysmian.com.
c. Southwire Company: www.southwire.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:

1. Feeders and Branch Circuits:

a. Size 10 AWG and Smaller: Solid.
b. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:

1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

2.5 METAL-CLAD CABLE

A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com.
2. Encore Wire Corporation: www.encorewire.com.
3. Southwire Company: www.southwire.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Grounding: Full-size integral equipment grounding conductor.

G. Armor: Steel, interlocked tape.

H. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.6 WIRING CONNECTORS AND TERMINATIONS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Wiring Connectors for Splices and Taps:

1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
3. Connectors for Aluminum Conductors: Use compression connectors.

C. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

F. Mechanical Connectors: Provide bolted type or set-screw type.

G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.7 WIRING ACCESSORIES

A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
5. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as shown on the drawings.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated and routing is not shown, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location shown.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:

    a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
    b. Increase size of conductors as required to account for ampacity derating.
    c. Size raceways, boxes, etc. to accommodate conductors.

8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is permitted where not otherwise prohibited, except for the following:
    a. Branch circuits fed from ground fault circuit interrupter (GFCI) circuit breakers.
    b. Branch circuits fed from feed-through protection of GFI receptacles.
    c. Branch circuits with dimming controls.
    d. Branch circuits with isolated grounding conductor.

B. Install products in accordance with manufacturer's instructions.

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

D. Install aluminum conductors in accordance with NECA 104.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

I. Terminate cables using suitable fittings.
1. Metal-Clad Cable (Type MC):
    a. Use listed fittings.
    b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

J. Install conductors with a minimum of 12 inches of slack at each outlet.

K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
    b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
    b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
3. Wet Locations: Use heat shrink tubing.

O. Insulate ends of spare conductors using vinyl insulating electrical tape.

P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

Q. Identify conductors and cables in accordance with Section 26 05 53.

R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

T. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Support and train all feeders within switchboards away from open bus bars and sharp metal edges within cabinets.

U. Neatly train and lace wiring inside boxes, equipment, and panelboards.

3.4 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 05 19

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Provide all components necessary to complete the grounding system(s) consisting of:

1. Existing metal underground water pipe.
2. Metal underground water pipe.
3. Metal frame of the building.
4. Concrete-encased electrode.
5. Metal underground gas piping system.
6. Rod electrodes.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide for grounding electrodes, connections and specific purpose conductors.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Project Record Documents: Record actual locations of components and grounding electrodes.

E. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:

1. Use insulated copper conductors unless otherwise indicated.

a. Exceptions:

1) Use bare copper conductors where installed underground in direct contact with earth.
2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

D. Cooper Power Systems, a division of Cooper Industries: www.cooperindustries.com.

E. Framatome Connectors International: www.fciconnect.com.

F. Lightning Master Corporation: www.lightningmaster.com.

G. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 CONNECTORS AND ACCESSORIES

A. Mechanical (Bolted) Connectors.

1. Bolted connectors for conductors and pipes: bronze, copper, and copper alloy, bolted compression type specifically manufactured for application needed.
2. Pipe connectors, clamp type, sized for pipe to be grounded.
3. Product: CADWELD manufactured by Erico.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Exothermic Connections:

1. Uses required: all concealed underground and structural steel.
2. Product: CADWELD manufactured by Erico.
3. Product: ULTRAWELD manufactured by Harger.
4. Product: EXOWELD manufactured by LP1.
5. Substitutions: See Section 01 60 00 - Product Requirements.

C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

C. Verify that conditions are satisfactory for installation prior to starting work.

D. Verify existing conditions prior to beginning work.

E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 26 05 53.

E. Install ground electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

1. Drive electrodes down until tops are at least 2" below finished grade, unless indicated otherwise.
2. Interconnect grounding electrodes with buried bare copper, 3/0 minimum size. Bury conductor at least 24" below finished grade.
3. Grounding electrode system shall consist of at least 3 electrodes spaced at least 10' apart preferably in a triangle arrangement.

F. Provide grounding well with cover at rod locations where indicated. Install with top flush to finished grade.

G. Install bare copper wire in foundation footing where indicated.

H. Provide bonding to meet requirements described in Quality Assurance. Bond in area readily accessible for inspection and maintenance, except for short runs in conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to/from rigidly mounted equipment.
3. Exothermic Welded Connections: required for all buried connections except where specifically noted to do otherwise.
4. Metal Water Service Pipe: Install insulated copper grounding conductors (in conduit) from building's main service equipment or grounding bus to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts on the flange. Where a dielectric main water fitting is installed, conduit or sleeve to conductor at each end.
5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
6. Above Ground Portion of Gas Piping System downstream from equipment shutoff valve.

I. Equipment/Device Specific Grounding & Bonding Requirements: Provide separate, insulated conductor within each feeder and branch circuit raceway according NFPA 70. Terminate each end on suitable lug, bus, or bushing.

1. In addition to NFPA 70 requirements, provide insulated grounding conductors for:
   a. Feeders and branch circuits.
   b. Lighting circuits.
   c. Receptacle circuits.
   d. Single phase motor and appliance circuits.
   e. 3-phase motor and appliance circuits.
   f. Flexible raceway runs.
   g. Armored and metal-clad cable runs.
2. Air-duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
3. Water Heater, Heat Tracing, and Anti frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment and components.
4. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
5. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4" x 2" x 12" grounding bus.

6. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
7. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch circuit conductors.

3.3 FIELD QUALITY CONTROL

A. Owner will provide field inspection in accordance with Section 01 40 00.

B. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

C. Inspect and test in accordance with NETA STD ATS except Section 4.

D. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

E. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

F. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

C. Equipment concrete pad requirements.

1.2 RELATED REQUIREMENTS

A. General Conditions, Supplementary Conditions and Division 01 apply to this section.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.

B. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2009.

C. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2006

D. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2010

E. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2009.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog data for fastening systems.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Welding: Qualify procedures and personnel according to AW D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - GENERAL

2.1 MATERIALS -- SUPPORT AND ATTACHMENT COMPONENTS

A. Hangers and Supports - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; hot-dipped galvanized after fabrication and applied according to MFMA-4.

1. Manufacturers -- Subject to compliance with requirements, manufacturers offering products that may be incorporated into the WORK include but are not limited to the following:

   a. Allied Tube and Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation
   d. GS Metals Corporation.
   e. Thomas and Betts Corporation
   f. Unistrut; Tyco International, Ltd.

2. Channel/strut dimensions: as selected for applicable load criteria.

3. Raceway and cable supports as described in NECA 1 and NECA 101.
4. Conduit and cable support devices -- hangers, clamps and associated fittings, designed for types and sizes of raceway or cable to be supported.
5. Supports for Conductors in Vertical Conduit -- Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
6. Structural Steel for Fabricated Supports and Restraints -- ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

C. Mounting Anchoring and Attachment Components -- Items for fastening electrical items, or their supports, to building surfaces including the following:

1. Powder-Actuated Fasteners: Threaded steel stud, for use in hardened portland cement, concrete, steel, or wood, with tension, shear and pullout capacities appropriate for the supported loads and building materials where used. Coordinate usage with General Contractor on precast structural members.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the WORK include, but are not limited to, the following:

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Stong-Tie Company Inc., Masterset Fastening Systems Unit.

2. Mechanical Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Available Manufacturers: Subject to the compliance with requirements, manufacturers offering products that may be incorporated into the WORK include, but are not limited to, the following:

        1) Cooper B-Line; a division of Cooper Industries.
        2) Empire Tool and manufacturing Company, Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable iron, slotted support system units similar to MSS, Type 18; comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All steel, spring head type.
7. Hanger rods: threaded steel.

D. Fabricated Metal Equipment Support Assemblies

1. Description: Welded or bolted, structural - steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2. Materials: Comply with requirements in Division 5 Section, "Metal Fabrications" for steel shapes and plates.

E. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.

1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
5. Manufacturers:

a. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
b. PHP Systems/Design: www.phpsd.com.
c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
d. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA101 for applications of hangers and supports for electrical equipment and systems except if requirements in this section are more stringent.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC and RMC as required by NFPA 70. Mininmum rod size shall be 1/4" in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in the future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 INSTALLATION

A. Supports

1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

2. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
4. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

    a. To Wood: Fasten with lag screws or through bolts.
    b. To New Concrete: Bolt to concrete inserts.
    c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    d. To Existing Concrete: Expansion anchor fasteners.
    e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
    f. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
    g. To Light Steel: Sheet metal screws.
    h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

5. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

B. Installation of Fabricated Metal Supports

1. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M

C. Concrete Bases

1. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
2. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3.
3. Anchor equipment to concrete base.

    a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

b. Install anchor bolts to elevations required for proper attachment to supported equipment.
c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

D. Painting

1. Touchup: Comply with requirements in Division 9 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

E. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.

1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
2. Obtain permission from Engineer before drilling or cutting structural members.

F. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.

I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION 26 05 29

SECTION 26 05 34 - CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Intermediate metal conduit (IMC).

D. PVC-coated galvanized steel rigid metal conduit (RMC).

E. Flexible metal conduit (FMC).

F. Liquid-tight flexible metal conduit (LFMC).

G. Electrical metallic tubing (EMT).

H. Rigid polyvinyl chloride (PVC) conduit.

I. Liquid-tight flexible nonmetallic conduit (LFNC).

J. Conduit fittings.

K. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 07 84 00 - Firestopping.

C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC) and armored cable (Type AC), including uses permitted.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 35 - Surface Raceways.

G. Section 26 05 37 - Boxes.

H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

I. Section 26 27 01 - Electrical Service Entrance: Additional requirements for electrical service conduits.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.

G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; National Electrical Contractors Association; 2004.

H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.

I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.

J. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association; 2005.

K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.

L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

M. NEMA TC 7 - Smooth Wall Coilable Electrical Polyethylene Conduit and fittings; National Electrical Manufacturers Association, 2005. Comply with ASTM 2160 and UL 651B.

N. NEMA TC-14 - Reinforced Thermosetting Resin Conduit (RTRC) and fittings; National Electrical Manufacturers Association; 2002. UL 1684.

O. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

Q. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

R. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

S. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

T. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

U. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

V. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

W. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

X. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

D. Product Data: Provide for metallic conduit, flexible metal conduit, liquid-tight flexible metal conduit, metallic tubing, nonmetallic conduit, flexible nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.

1.6 QUALITY ASSURANCE

A. A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on

either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:

1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Within Hollow Metal Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

1. Locations subject to physical damage include, but are not limited to:

a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit or aluminum rigid metal conduit.

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
1. Maximum Length: 6 feet.

O. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquid-tight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:

    a. Transformers.
    b. Motors.

2.2 CONDUIT REQUIREMENTS

A. Electrical Service Conduits: Also comply with Section 26 27 01.

B. Communications Systems Conduits: Also comply with Section 27 05 28.

C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

D. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

E. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 1/2 inch (16 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
5. Underground, Interior: 3/4 inch (21 mm) trade size.
6. Underground, Exterior: 1 inch (27 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Thread-less set screw and compression (gland) type fittings are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use aluminum.
3. Connectors and Couplings: Use threaded type fittings only. Thread-less set screw and compression (gland) type fittings are not permitted.

2.5 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Thread-less set screw and compression (gland) type fittings are not permitted.

2.6 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

C. PVC-Coated Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.7 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

2.8 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

C. Description: Interlocked steel construction with PVC jacket.

2.9 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use compression (gland) or set-screw type.
    a. Do not use indenter type connectors and couplings.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.11 LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Description: NFPA 70, Type LFNC liquid-tight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

B. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.12 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

D. Verify routing and termination locations of conduit prior to rough-in.

E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

I. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
    a. Electrical rooms.
    b. Mechanical equipment rooms.
    c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
    a. Across floors.
    b. Across roofs.
    c. Across top of parapet walls.
    d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
9. Route conduits above water and drain piping where possible.
10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to.
    a. Heaters.
    b. Hot water piping.
    c. Flues.
13. Group parallel conduits in the same area together on a common rack.

J. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

K. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquid-tight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and rain-tight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

L. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

M. Underground Installation:

1. Minimum Cover, Unless Otherwise Indicated or Required:

   a. Underground, Exterior: 24 inches.
   b. Under Slab on Grade: 12 inches to bottom of slab.

2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):

1. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.

2. Install conduits within middle one third of slab thickness.
3. Secure conduits to prevent floating or movement during pouring of concrete.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

P. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

Q. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

R. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

S. Provide grounding and bonding in accordance with Section 26 05 26.

T. Identify conduits in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 34

SECTION 26 05 37 - BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall and ceiling outlet boxes.

B. Floor boxes.

C. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

C. Section 26 27 26 - Wiring Devices: Wall plates in finished areas.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.

C. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008.

D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 2008.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

B. Nonmetallic Outlet Boxes: NEMA OS 2, for use in dwelling units in Type II, IV, and V construction.

C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

E. Television Wall Boxes: Provide for FSR #PWB-200 (7" x 7" x 4") project wall box at each individual wall-mounted television.

2.2 FLOOR BOXES

A. Floor Boxes: NEMA OS 1, fully adjustable, 1-1/2 inches deep.

B. Material: Cast metal.

C. Shape: Round.

D. Service Fittings: As specified in Section 26 27 26.

2.3 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.

C. Coordinate installation of outlet boxes for equipment connected under Section 26 27 17.

D. Set wall mounted boxes at elevations to accommodate mounting heights indicated.

E. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.

1. Adjust box locations up to 10 feet if required to accommodate intended purpose.

F. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

G. Maintain headroom and present neat mechanical appearance.

H. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

I. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

J. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

K. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

L. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

M. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

N. Use flush mounting outlet box in finished areas.

O. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

P. Provide separate boxes for emergency power and normal power systems.

Q. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

R. Locate outlet boxes so that wall plates do not span different building finishes.

S. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation.

1. Provide minimum 24 inches separation in acoustic rated walls.
2. Provide minimum 24 inches separation in fire rated walls.

T. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

U. Use stamped steel bridges to fasten flush mounting outlet box between studs.

V. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

W. Provide vapor sealing type boxes or additional vapor barrier enclosures around boxes located in exterior walls in wood or metal stud framing.

X. Use adjustable steel channel fasteners for hung ceiling outlet box.

Y. Do not fasten boxes to ceiling support wires.

Z. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

AA. Use gang box where more than one device is mounted together. Do not use sectional box.

AB. Use gang box with plaster ring for single device outlets in Type I and II construction areas.

AC. Use cast outlet box in exterior locations exposed to the weather and wet locations.

AD. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

AE. Set floor boxes level.

AF. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

AG. Identify boxes in accordance with Section 26 05 53.

3.2 ADJUSTING

A. Adjust floor boxes flush with finish flooring material.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused box openings.

3.3 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 26 05 37

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Floor marking tape.

G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 09 90 00 - Painting and Coating.

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

C. Section 26 27 26 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2007.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2007.

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2009.

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 - PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Switchboards:

1) Identify power source and circuit number. Include location when not within sight of equipment.
2) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Panelboards:

1) Identify power source and circuit number. Include location when not within sight of equipment.
2) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
3) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

c. Enclosed switches, circuit breakers, and motor controllers:

1) Identify power source and circuit number. Include location when not within sight of equipment.
2) Identify load(s) served. Include location when not within sight of equipment.

d. Time Switches:

1) Identify load(s) served and associated circuits controlled. Include location.

e. Enclosed Contactors:

1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
4) Identify coil voltage.
5) Identify load(s) and associated circuits controlled. Include location.

f. Transfer Switches:

1) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

2. Service Equipment:

a. Use identification nameplate to identify each service disconnecting means.
b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
c. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.

3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
8. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.

    a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 90 00.

9. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.

    a. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use underground warning tape to identify direct buried cables.

C. Identification for Raceways:

1. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.

    a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.

        1) Color Code:

            (a) Fire Alarm System: Red.

        2) Field-Painting: Comply with Section 09 90 00.
        3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.

2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

3. Use underground warning tape to identify underground raceways.

D. Identification for Boxes:

1. Use voltage markers or color coded boxes to identify systems other than normal power system.
    a. Color-Coded Boxes: Field-painted in accordance with Section 09 90 00 per the same color code used for raceways.
        1) Fire Alarm System: Red.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
    a. For exposed boxes in public areas, use only identification labels.

E. Identification for Devices:

1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
2. Use identification label to identify fire alarm system devices.
3. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
5. Use identification label to identify power source on all duplex & quadplex devices.
6. Use identification label to identify end use of all non-lighting switches, i.e., projector screen, roller shades, etc.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
    a. Indoor Clean, Dry Locations: Use plastic nameplates.
    b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
    a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
    a. System designation where applicable:
        1) Fire Alarm System: Identify with text "FIRE ALARM".
    b. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
    a. System Designation: 1 inch.
    b. Equipment Designation: 1/2 inch.
5. Color:
    a. Normal Power System: White text on black background.
    b. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.

3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

C. Minimum Size:

1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

D. Legend:

1. Markers for System Identification:

E. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:

2.6 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:

1. Materials:
2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
    a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 - PRODUCTS

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 05 53

SECTION 26 05 83 – ELECTRICAL CONNECTIONS TO EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this Section.

B. This Section is a Division 26 Basic Materials and Methods Section and is part of each Division 22, 23 and 26 section making reference to electrical connections for equipment specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:

1. To motors.
2. To temperature control equipment
3. To elevators

C. Electrical connections for equipment not furnished as integral part of equipment are specified in Divisions 22, 23 and other Division 26 sections, and are work of this section.

D. Motor starters and controllers not furnished as integral part of equipment are specified in applicable Division 26 sections.

E. Refer to Divisions 22 and 23 sections for motor starters and controllers furnished integrally with equipment.

F. Refer to Divisions 22 and 23 sections for connection requirements for temperature control equipment.

G. Junction boxes and disconnect switches required for connection motors and other electrical units of equipment are specified in applicable Division 26 sections.

1.3 QUALITY ASSURANCE

A. NEC Compliance. Comply with applicable requirements of NEC as to type of products used and installation of electrical power connections (terminals and splices) for junction boxes, motor starters, and disconnect switches.

B. ANSI Compliance. Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

C. Compliance with Testing Laboratories. Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors", including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials that are listed and labeled by nationally-recognized testing laboratories.

1.4 SHOP DRAWINGS

A. Shop drawings are not required for work described in this section.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials, including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations.

B. Raceways and fittings. Provide raceways and fittings of types, grades, sizes, and weights (wall thicknesses) indicated for each type service. Provide products complying with Section 26 05 34.

C. Wires, Cables, and Connectors. Provide wires, cables, and connectors complying with Division 26 05 19 which are listed for use for the particular application.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connections as indicated, in accordance with equipment manufacturer's written instructions, with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway, and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connection for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than, electrical insulation rating of those conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

F. Trim cables and wires as short as practical and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torqueing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.

H. Fasten identification markers to each electrical power supply wire/cable conductor in accordance with Division 26 Section "Electrical Identification". Affix markers on each terminal conductor as close as possible to the point of connection.

3.3 CONNECTIONS TO MOTORS

A. Make electrical connections to all motors, appliances, and other equipment and associated control devices in accordance with the schedules on the drawings and as hereinafter specified.

1. In each case, verify connections and physical data from approved shop drawing, manufacturer's wiring diagrams, and/or detail drawings provided by relevant trade subcontractor.
2. Generally, all motors and equipment will be furnished and set in place by others, and the electrical contractor shall make all connections thereto. Where indicated in schedules and specified, this contractor shall furnish and install

starter, manual controls, and auxiliary equipment. This contractor shall furnish and install all disconnect switches required by code.

B. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration. Flexible conduit connections shall be not less than 12" no more than 18".

C. When connecting adjustable speed drives (ASDs) to a motor, install the conductors from the drive to the motor in a separate raceway. Installing conductors in a common conduit or wireway is not acceptable.

3.4 CONNECTIONS TO TEMPERATURE CONTROL EQUIPMENT

A. Make electrical connections to temperature control equipment as indicated in the plans and specifications and according to the manufacturer's written instruction. Coordinate with the mechanical contractor.

3.5 CONNECTIONS TO ELEVATOR

A. Provide smoke detectors in elevator shaft, each elevator lobby, and equipment room to initiate Phase I emergency recall upon activation of detectors.

B. Power for machine room lights and receptacles shall be on separate branch circuit.

C. Power for hoistway pit lights and receptacles shall be on separate branch circuit.

D. Receptacles in hoistway pit and machine room shall be GFCI type.

E. Lighting in hoistway pit and machine room shall not be connected to the load side of the GFCI receptacle in the space.

F. Provide 15 ampere lockable, fused disconnect switch for elevator cab light and power.

G. Verify location of all equipment in pit, shaft and machine room with elevator contractor.

3.6 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site; then retest to demonstrate compliance.

END OF SECTION 26 05 83

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 DEVICES

A. Outdoor Photoelectric Switches: Solid state, with DPST dry contacts rated for 1800-VA tungsten, to operate connected relay, contactor coils, and microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 15-second minimum.
3. Surge Protection: Metal-oxide varistor.

B. Indoor, Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit complying with UL 773A, with separate relay unit rated for 20-A ballast load at 120- and 277-V ac. Cadmium sulfide photoresistors are not acceptable.

1. Type: Dual technology (passive infrared and ultrasonic).
2. Voltage: 120/277 V.
3. Switch Rating: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac.
4. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
5. Time Delay: Adjustable from 5 to 300 seconds.
6. Set-Point Adjustment: With deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
7. Indicator: Two LEDs.

C. Indoor, Wall-Switch Occupancy Sensors:

1. Type: Dual technology (passive infrared and ultrasonic).
2. Voltage: 120/277 V.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
4. Time Delay: Adjustable up to 30 minutes.
5. Field of View: 180 degrees.
6. Minimum Coverage Area: 900 sq. ft.

D. High Bay Occupancy Sensors:

1. Type: Dual technology (passive infrared and ultrasonic).
2. Voltage: 120/277 V.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
4. Time Delay: Adjustable up to 30 minutes.
5. Field of View: Aisle bi-directional or high bay 360 degrees based on installation location.
6. Minimum Coverage Area: 900 sq. ft.

E. Outdoor, Weatherproof Motion Sensors:

1. Type: Passive infrared.
2. Switch Rating:
   a. Lighting-Fixture-Mounted Sensor: 500-VA fluorescent.
   b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac.
3. Voltage: 120/277 V.
4. Time Delay: Adjustable up to 15 minutes.
5. Detection Coverage: 180-degree field of view and 110-foot detection range.

F. Lighting Contactors: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

C. Label time switches and contactors with a unique designation.

D. Verify actuation of each sensor and adjust time delays.

END OF SECTION 26 09 23

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Lighting and appliance panelboards.

B. Load centers.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2006.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.

G. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 67 - Panelboards; Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

N. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

O. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current

ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Siemens Industry, Inc: www.sea.siemens.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ALL PANELBOARDS

A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature:
    a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings. (22,000 AIC)
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
3. Label equipment utilizing series ratings as required by NFPA 70.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    a. Indoor Clean, Dry Locations: Type 1.
2. Boxes: Galvanized steel unless otherwise indicated.
    a. Provide wiring gutters sized to accommodate the conductors to be installed.
    b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
3. Fronts:
    a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
    b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
    c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

L. Provide the following features and accessories where indicated or where required to complete installation:
1. Feed-through lugs.
2. Sub-feed lugs.

2.3 LIGHTING AND APPLIANCE PANELBOARDS (HOUSE PANELS)

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Aluminum.
3. Ground Bus Material: Aluminum.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LOAD CENTERS

A. Description: Circuit breaker type load centers listed and labeled as complying with UL 67; ratings, configurations, and features as indicated on the drawings.

B. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Bus Material: Aluminum or copper.

C. Circuit Breakers: Thermal magnetic plug-in type.

D. Enclosures:

1. Provide flush-mounted enclosures unless otherwise indicated.
2. Fronts: Provide hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide circuit directory label on inside of door or individual circuit labels adjacent to circuit breakers.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
        1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
    c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
    a. Provide mechanical lugs unless otherwise indicated.
    b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
6. Provide the following circuit breaker types where indicated.
    a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
    b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
    c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
    d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
7. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.

2.6 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 05 29.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

I. Provide grounding and bonding in accordance with Section 26 05 26.

J. Install all field-installed branch devices, components, and accessories.

K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

L. Provide filler plates to cover unused spaces in panelboards.

M. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:

1. Emergency and night lighting circuits.
2. Fire detection and alarm circuits.
3. Intrusion detection and access control system circuits.
4. Video surveillance system circuits.

3.3 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Test GFCI circuit breakers to verify proper operation.

D. Test AFCI circuit breakers to verify proper operation.

E. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and

adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

2.2 COMMERCIAL-GRADE DEVICES

A. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

B. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

C. Convenience Receptacles: NEMA WD 1, NEMA WD 6, Configuration 5-20R, and UL 498.

D. Duplex GFCI Convenience Receptacles: 125 V, 20 A, straight blade, feed-through type. NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

C. Select device colors and wall plates as follows:

1. Devices: gray.
2. Device wall plates: stainless steel.
3. In addition to all duplex receptacles shown on construction documents, Contractor shall provide for (5) additional duplex receptacles to be changed out to gray/stainless steel, which will be incorporated into design during the construction duration.

D. Mount devices flush, with long dimension vertical, and grounding terminal of receptacles on top unless otherwise indicated. Group adjacent devices under single, multigang wall plates.

END OF SECTION 26 27 26

SECTION 26 28 16 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED WORK

A. Transformers.

B. Secondary Grounding.

1.2 INDUSTRY STANDARDS

A. Equipment specified herein shall meet the applicable standards of the following agencies and associations.

1. Underwriters' Laboratories, UL.
2. Institute of Electrical and Electronic Engineers, IEEE.
3. National Electrical Manufacturers Association, NEMA.

1.3 SUBMITTALS

A. Furnish to the Architect shop drawings for the following items:

1. Safety switches.

B. All these items shall be by the same manufacturer as the switchboards and panel boards.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Safety switches shall be heavy duty, fused unless noted otherwise, with number of poles, electrical characteristics, ratings and modifications as required. When used as service entrance equipment unit shall be labeled as such.

B. Switching mechanism shall be quick-make, quick-break, with handle that is padlockable in the "Off" position.

C. When safety switches are provided to control mechanical equipment it shall be Division 26 Contractor's responsibility to verify the number of poles needed and speed.

D. Enclosure shall be suitable for the area in which it is to be installed and shall have a defeatable door interlock which prevents the door from opening when the switch is "on".

E. Fusible units are to be equipped with current limiting fuses and shall have fuseholders with rejection clips to prevent other type fuses from being installed.

F. Safety switches shall be as manufactured by Siemens, Square D, General Electric, Westinghouse or Cutler-Hammer.

2.2 FUSES

A. Fuses shall be non-renewable with 200,000 amperes RMS symmetrical interrupting capacity.

1. Class RK5 units shall be non-renewable, time-delay type:
   a. Standards:
      Low-Peak; LPN-RK & LPS-RK - Bussman Co.
      Amp-Trap; TR-R and TRS-R - Gould-Shawmut Co.
      LON-RK and LOS-RK - CEFLO.

2. Class L units.
   a. Standards:
      LIMITRON; KRP-C - Bussman Co.
      AMP-TRAP; A4BY - Gould-Shawmut Co.
      CLL-CEFLO.

3. Class J units.
   a. Standards:
      Limitron; JKS - Bussman Co.
      Amp-Trap; A4J - Gould-Shawmut Co.
      CJS - CEFLO.

B. Provide the Owner with 10% or three (3) spare fuses, whichever is greater, of each size and type used on the Project.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Safety switches shall be installed where shown at 6' from floor to top of switch, unless otherwise noted.

B. Install all items securely to walls, columns, or machine frames, and be responsible for all necessary brackets, mounting devices, structural pieces, anchors and/or inserts necessary for this purpose.

C. Do not mount equipment directly to masonry or concrete walls. Provide a 3/4" plywood panel on the wall and securely mount equipment on the plywood. Approved alternate method of mounting equipment is mounting equipment on strut. Approved manufacturers are: B-Line, Kindorf/Superstrut, Unistrut or approved equal.

END OF SECTION 26 28 16

SECTION 26 28 17 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Fusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type HD, that accommodate specified fuses, and with lockable handle interlocked with cover in closed position.

B. Nonfusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type HD, with lockable handle interlocked with cover in closed position.

C. Shunt Trip Switches: Comply with UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Description: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with field-adjustable instantaneous trip settings.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

5. GFEP Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

B. Features and Accessories:

1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
2. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.4 ENCLOSURES

A. NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260500 "Common Work Results for Electrical."

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 26 28 17

SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:
   1. Product Data for each luminaire, including lamps.
   2. Calculated footcandle plots, for both interior & exterior lighting, showing specific illumination on an adequate grid, accounting for layout & mounting height.
   3. Hard copy charts of available colors/finishes, to be mailed to Architect, for all fixtures listed as "color selection by Architect". Colors/finishes will not be selected by Architect, based off online or other electronic methods.

B. An "Approved Equal" will be considered for most light fixture types. Pre-bid approval (10-days prior) by Heinz Associates LLC and subsequent listing in an Addendum is required to bid fixtures not listed in the schedule.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fixtures, Emergency Lighting Units, Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Exterior Luminaires: Comply with UL 1598 and listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

F. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2.3 EXIT SIGNS

A. Internally Lighted Signs: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

1. Lamps for AC Operation: LEDs, 70,000 hours minimum of rated lamp life.

2.4 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
4. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Confirm fixture mounting requirements with Architectural drawings prior to ordering, including but not limited to fixture elevations, drywall lid vs. suspended ceiling tile, etc.

B. Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work, and security and fire-prevention features mounted in ceiling space and on ceiling.

C. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

D. Comply with NFPA 70 for minimum fixture supports.

E. Seismic Protection: Luminaire attachments to building walls and ceilings shall comply with seismic criteria in Section 260500 "Common Work Results for Electrical."

F. Suspended Lighting Fixture Support:

1. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
2. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
3. All suspended lighting fixtures shall utilize aircraft cable & SO cord.

G. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.

H. Adjust aimable lighting fixtures to provide required light intensities. Any exterior aimable lighting fixtures shall be adjusted during nighttime hours.

END OF SECTION 26 50 00

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

1.2 Related Requirements:

1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS

2. 270501 PATHWAYS FOR COMMUNICATIONS

3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS

4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

5. 270504 COMMUNICATIONS BACKBONE CABLING

6. 270505 CABLE TRAYS FOR COMMUNICATIONS

7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

2.2 PATHWAYS

A. General: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Comply with TIA-569-B.

B. Metal Conduits and Fittings:
1. EMT: ANSI C80.3 and UL 797.
2. GRC: ANSI C80.1 and UL 6 hot-dip galvanized.
3. Raceway Fittings: Specifically designed for raceway type used in Project.

C. Nonmetallic Conduits and Fittings:
1. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
2. Continuous HDPE: Comply with UL 651B.
3. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

D. Optical-Fiber and Communication Cable Pathways and Fittings: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

E. Surface Pathways:
1. Metal: Galvanized steel with snap-on covers, complying with UL 5. Manufacturer's standard enamel finish.
2. Nonmetallic: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.

F. Wire-Basket Cable Trays: High-strength-steel longitudinal wires with no bends, formed into a standard 18"x4" wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
1. Straight sections shall be furnished in standard 118-inch lengths.

2.3 SLEEVES FOR PATHWAYS AND CABLES

A. Wall Sleeves:
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
3. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
4. Sleeves for Rectangular Openings: Galvanized-steel sheet.

B. Grout: Nonmetallic, shrinkage-resistant grout, ASTM C 1107, factory-packaged, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

1. Silicone Sealant: Single-component, neutral-curing elastomeric sealant, pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

2.4 RACEWAY IDENTIFICATION MATERIALS

A. Self-adhesive, color-coding vinyl tape; flexible, preprinted, self-adhesive vinyl.

PART 3 - EXECUTION

3.1 GENERAL COMMUNICATION EQUIPMENT INSTALLATION REQUIREMENTS

A. Install communication equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

B. Install communication equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.

C. Install communication equipment to allow right of way for piping and conduit installed at required slope.

D. Install communication equipment to ensure that connecting pathways and cables are clear of obstructions and of the working and access space of other equipment.

E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Comply with requirements in Section 083113 "Access Doors and Frames."

G. Install sleeve and sleeve seals of type and number required for sealing communication service penetrations of exterior walls.

H. Identify accessible pathways with green and yellow color-coded, self-adhesive color-coding tape-in bands.

3.2 PATHWAY AND CABLE INSTALLATION

A. General: Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements.

B. Outdoor Pathways Applications:
1. Exposed: GRC
2. Concealed Aboveground: GRC.

3. Underground, Single Run: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment: LFMC.
5. Boxes and Enclosures: NEMA 250, Type 4.

C. Indoor Pathways Applications:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Physical Damage: GRC.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT or cable tray.
4. Damp or Wet Locations: GRC.
5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
6. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, optical-fiber-cable pathway.
7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250, Type 4 nonmetallic in damp or wet locations.

D. Minimum Raceway Size: 3/4-inch trade size. The minimum size for optical-fiber cables is 1 inch.

E. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

F. Install pathways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

G. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

H. Install pull wires in empty raceways.

I. Wire-Basket Support Method:
1. Support wire-basket cable trays with trapeze hangers.
2. Support trapeze hangers for wire-basket trays with 1/4-inch diameter rods.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

3.4 SLEEVE AND SLEEVE-SEALS INSTALLATION

A. Cut sleeves to length for mounting flush with both wall surfaces. Extend sleeves installed in floors 2 inches above finished floor level.

B. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

C. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

D. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Section 079200 "Joint Sealants."

E. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Comply with NEMA VE 2 for cable tray and cable penetrations.

G. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.5 FIRESTOPPING

A. Apply firestopping to communications penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 27 05 00

SECTION 27 05 01 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Surface pathways.
7. Boxes, enclosures, and cabinets.

B. Related Requirements:
1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
2. 270501 PATHWAYS FOR COMMUNICATIONS
3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
5. 270504 COMMUNICATIONS BACKBONE CABLING
6. 270505 CABLE TRAYS FOR COMMUNICATIONS
   271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

C. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

D. Provide: Furnish and install, complete and ready for the intended use.

E. All placement & material for wall sleeves, conduit, & cable tray should be coordinated between the Electrical Contractor and Low-Voltage Contractor prior to bid submittal. This should include any core drilling requirements.

F. The Low-Voltage Contractor will be responsible for providing and installing appropriate-size J-hooks rated for UTP cable installation. All cables should be supported with no less than 5' spacing. This includes any area not supported by cable tray. J-hook should not be shared with other vendors.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Alpha Wire Company.
4. Anamet Electrical, Inc.
5. Southwire Company.
6. Thomas & Betts Corporation.
7. Western Tube and Conduit Corporation.
8. Wheatland Tube Company, a division of John Maneely Company.
9. Approved Equals

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Setscrew.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corp.
7. Approved Equal

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

F. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

G. Rigid HDPE: Comply with UL 651A.

H. Continuous HDPE: Comply with UL 651B.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL FIBER CABLE PATHWAYS & FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Arnco Corporation.
2. Endot Industries, Inc.
3. IPEX.
4. Lamson & Sessions; Carlon Electrical Products.
5. Approved Equal

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 SURFACE PATHWAYS (NO SURFACE PATHWAY ALLOWED ON THIS PROJECT)

A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.

3. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Hubbell Incorporated; Wiring Device-Kellems Division.
b. Panduit Corp.
c. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Chatsworth (CPI).
2. Panduit
3. Hubbell

General Requirements for Boxes, Enclosures, and Cabinets:

4. Comply with TIA-569-B.
5. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

B. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

C. Box extensions used to accommodate new building finishes shall be of same material as recessed boxes.

Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

E. Device Box Dimensions: 4 inches square by 2-1/2 inches deep.

F. Gangable boxes are allowed.

G. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
1. Hinged door in front cover with flush latch and concealed hinge.
2. Key latch to match panelboards.
3. Metal barriers to separate wiring of different systems and voltage.
4. Accessory feet where required for freestanding equipment.

2.6 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: RNC, Type EPC-40-PVC.
2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried concrete encased.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT RNC, Type EPC-40-PVC or innerduct.
5. Damp or Wet Locations: GRC IMC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway Plenum-type, communications-cable pathway EMT.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway Riser-type, communications-cable pathway EMT.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway Riser-type, optical-fiber-cable pathway Plenum-type, optical-fiber-cable pathway General-use, communications-cable pathway Riser-type, communications-cable pathway Plenum-type, communications-cable pathway EMT.
9. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel or cast-metal fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120°F.

2.7 INSTALLATION

Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

A. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

B. Complete pathway installation before starting conductor installation.

C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches of enclosures to which attached.

H. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor.

Stub-ups to Above Recessed Ceilings:

6. Use EMT, IMC, or RMC for pathways.
7. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

M. Cut conduit perpendicular to the length. For conduits of 2-inc. Cap underground pathways designated as spare above grade alongside pathways in use.h trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

N. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire

O. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid, and flexible, as follows:

4. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
5. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
6. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

P. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Q. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

R. Horizontally separate boxes mounted on opposite sides of wall, so they are not in the same vertical channel.

S. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

T. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

U. Set metal floor boxes level and flush with finished floor surface.

2.8 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

B. It is the responsibility of the Low Voltage Vendor to firestop all communication fire wall penetrations after all cables have been pulled and tested.

2.9 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 01

SECTION 27 05 02 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and 27 Specification Sections, apply to this Section.

B. Related Requirements:
1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
2. 270501 PATHWAYS FOR COMMUNICATIONS
3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
5. 270504 COMMUNICATIONS BACKBONE CABLING
6. 270505 CABLE TRAYS FOR COMMUNICATIONS
7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
1. Sleeve-seal systems.
2. Sleeve-seal fittings.
3. Grout.
4. Silicone sealants.

B. All Work specified under this Section shall be fully compliant with following:

1. ANSI/TIA/EIA-568 Commercial Building Telecommunications Cabling Standard (Currently Ratified).
1. ANSI/TIA/EIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces (Currently Ratified).
2. ANSI/TIA/EIA-606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Building (Currently Ratified).
3. ANSI-J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications (Currently Ratified).

In addition, all Work shall fully comply with these specifications and related Drawings and all manufacturers' recommended installation practices.

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

1. To provide for ease of disconnecting the equipment with minimum interference to other installations.
2. Connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
3. Cable supporting devises with round surfaces (i.e., bridal rings) are not acceptable.
4. Do not route communications cabling through structural roof joists.
5. Do not share or allow sharing of pathways with other system wiring such as alarm and audio wiring.
6. The electrical contractor and the low voltage contractor should communicate prior to bid to discuss responsibility of sleeve installations. There are no revisions for failure to provide bid pricing for all sleeve installations.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.4 DEFINITIONS

A. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

B. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

C. Provide: Furnish and install, complete and ready for the intended use.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain end with plastic bushings.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch 0.6-mm minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

Manufacturers: Subject to compliance with requirements, provide products by one of the following approved suppliers.

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.
f. Approved Equal

Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

Manufacturers: Subject to compliance with requirements, provide products by one of the following approved suppliers.

a. Presealed Systems.
b. Approved Equal.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

1. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

2.5 SPILLWAY "WATERFALL" DEVISE

A. Provide spillway device at all sleeved penetrations into telecommunications rooms to protect cabling bend radius restrictions transitioning to cable tray. In addition, provide spill way device anywhere the cabling pathway changes elevations such that communications cabling rests upon the sleeve edge potentially damaging cabling.

B. Provide Panduit CWF400 Waterfall or approved equal.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall, so no voids remain. Tool exposed surfaces smooth; protect material while curing.
c. All penetrations shall utilize pipe sleeves. No direct wall penetration with cable.

Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
4. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

1. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install them in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 27 05 02

SECTION 27 05 03 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2. Related Requirements:
   1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
   2. 270501 PATHWAYS FOR COMMUNICATIONS
   3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
   4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
   5. 270504 COMMUNICATIONS BACKBONE CABLING
   6. 270505 CABLE TRAYS FOR COMMUNICATIONS
   7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

1.2 SUMMARY

1. Section Includes:

   Telecommunications mounting elements.
   1. Telecommunications equipment 19" racks & cabinets.
   2. Grounding.

1.3 DEFINITIONS

1. BICSI: Building Industry Consulting Service International.

2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

3. EMI: Electromagnetic interference.

4. IDC: Insulation displacement connector.

5. LAN: Local area network.

6. RCDD: Registered Communications Distribution Designer.

7. UTP: Unshielded twisted pair.

8. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

9. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

10. Provide: Furnish and install, complete and ready for the intended use.

1.4 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
b. Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. All Work specified under this Section shall be fully compliant with following:

1. ANSI/TIA-568-C.1-2009 "Commercial Building Telecommunications Cabling Standard (Currently Ratified) including all addenda and subsets."
2. ANSI/TIA-569-C-2012 "Telecommunications Pathways and Spaces (Currently Ratified) including all addenda and subsets."
3. ANSI/TIA-606-B-2012 "Administrative Standard for the Telecommunications Infrastructure (Currently Ratified) including all addenda and subsets."
4. ANSI/TIA-607-B-2012 "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises (Currently Ratified) including all addenda and subsets."
5. ANSI/TIA-758-B-2012 "Customer-owned Outside Plant Telecommunications Infrastructure Standard (Currently Ratified) including all addenda and subsets."
6. In addition, all Work shall fully comply with these specifications and related Drawings and all manufacturers' recommended installation practices.

B. Installer Qualifications: Low-Voltage Contractor must be qualified to install Panduit UTP cable & associated hardware. Provide supporting documentation with bid package, indicating any Panduit certifications, with name, number, & expiration date.

C. Installation Supervision: Installation shall be under the direct supervision of qualified technician in the installation of Panduit communications equipment. This technician shall be present when Work of this Section is performed at Project site.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Cable supporting devices with round surfaces (i.e., bridal rings) are not acceptable.
3. Do not route communications cabling through structural roof joists.
4. Do not share or allow sharing of pathways with other system wiring such as alarm and audio wiring.
5. Straps and other devices.

2.2 EQUIPMENT FRAMES

1. Manufacturers: Subject to compliance with requirements, provide products by the following approved supplier.

1. Panduit

2. General Frame Requirements:

Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

1. Module Dimension: Width compatible with EIA 310-D standard, 19-inch 480-mm panel mounting. Provide a minimum 18" ladder cable tray in IT Room. All racks require a CPI tray-to-rack or -cabinet mounting attachment.
2. Finish: Manufacturer's standard, baked-polyester powder coat.

3. Universal Cable Racks (IN IDF'S)

Metal, with integral wire retaining fingers.

1. Baked-polyester powder coat finish.
2. Vertical cable management panels shall have front and rear channels, with covers.

3. Racks will be mounted to the floor.
4. Racks will be 19" Universal CPI or Panduit.
5. Ground all racks to Buss Bar connected to MGN of building.
6. Install 6" wire managers with doors on both sides.

2.3 POWER STRIPS

1. Power Strips: Comply with UL 1363.

   Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
1. Corded horizontal cabinet/rack mounting.
2. Provide Panduit #CMRPSH20 or approved equal.

2.4 GROUNDING

1. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

C. Telecommunications Main Bus Bar:

   Connectors: Mechanical type, cast silicon bronze, solderless -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
1. Ground Bus Bar: Copper, minimum ¼" thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
2. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2. Comply with ANSI/TIA-607-B-2012.

2.5 LABELING

1. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

1. Environmental Limitations: Do not deliver or install wall cabinet until space is enclosed and weathertight, wet work in space is complete and dry, and work above ceiling is complete.

3.2 CLEANING AND PROTECTION

1. Protect system components from damage and deterioration during installation. Protect equipment from dust and debris during installation. After installation maintain equipment protection. Notify other trades of equipment sensitivity to dust and debris. Clean equipment upon completion of Work.

B. Before final acceptance, clean system components.

3.3 COORDINATION

1. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

    1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces. This must be done prior to starting any installation.
    2. Record agreements reached in meetings and share them with the other participants.
    3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
    4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

2. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.4 ENTRANCE FACILITIES (THIS SHOULD BE COORDINATED BY THE OWNER.)

1. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

2. Comply with requirements in Division 27 Section "Communications Entrance Conduits" for materials and installation requirements for underground pathways.

3.5 INSTALLATION

1. Comply with NECA 1.

2. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

3. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

4. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

5. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

   Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

   1. Record agreements reached in meetings and share them with the other participants.
   2. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
   3. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

6. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

7. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

1. Comply with requirements in Division 07 Section "Penetration Firestopping."
2. Comply with TIA-569-B, Annex A, "Firestopping."
3. Comply with BICSI TDMM, "Firestopping Systems" Article.
4. Installation of firestopping should be coordinated between the Electrical Contractor and the Low-Voltage Contractor.

3.7 GROUNDING

1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

2. Comply with ANSI/TIA-607-B-2012.

3. Grounding bus bar should be located to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch 50-mm clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

5. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.8 IDENTIFICATION

1. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2. Comply with requirements in Division 09 Section "Interior Painting" for painting back-boards. For fire-resistant plywood, do not paint over manufacturer's label.

3. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.

4. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 05 03

SECTION 27 05 04 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2. Related Requirements:
   1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
   2. 270501 PATHWAYS FOR COMMUNICATIONS
   3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
   4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
   5. 270504 COMMUNICATIONS BACKBONE CABLING
   6. 270505 CABLE TRAYS FOR COMMUNICATIONS
   7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

1.2 SUMMARY

1. Section Includes:

   Pathways.
   1. UTP cable.
   2. Optical fiber cabling.
   3. Cable connecting hardware, patch panels, and cross-connects.
   4. Cabling identification products.

1.3 DEFINITIONS

1. BICSI: Building Industry Consulting Service International.

2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

3. EMI: Electromagnetic interference.

4. IDC: Insulation displacement connector.

5. LAN: Local area network.

6. RCDD: Registered Communications Distribution Designer.

7. UTP: Unshielded twisted pair.

8. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

9. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

10. Provide: Furnish and install, complete and ready for the intended use.

1.4 BACKBONE CABLING DESCRIPTION AND SCOPE OF WORK:

A. The backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. A cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. Provide a 12-strand single-mode outdoor fiber cable, from the Administration Building to the 1st floor MDF. This will be pulled through existing conduit from Administration Building up to new Center for Health Sciences, then pulled through new handholes & conduit into the building.

D. Provide a 12-strand single-mode indoor fiber cable, from the 1st floor MDF to the 2nd floor IDF. This will be in new sleeves installed by the electrical contractor between the 1st and 2nd floor closets.

E. Provide a Panduit fiber panel in each IT Room, equipped with 12-strand single-mode fiber cable terminated on a 12-port LC adapter panel. Test fiber cable and label the adapter panel.

1.5 PERFORMANCE REQUIREMENTS

1. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

1.6 ACTION SUBMITTALS

1. Product Data with Shop Drawings:

Product Data:

For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

a. Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

1.7 INFORMATIONAL SUBMITTALS

1. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.8 QUALITY ASSURANCE

1. All Work specified under this Section shall be fully compliant with following:

ANSI/TIA-568-C.1-2009 "Commercial Building Telecommunications Cabling Standard (Currently Ratified) including all addenda and subsets."

1. ANSI/TIA-569-C-2012 " Telecommunications Pathways and Spaces (Currently Ratified) including all addenda and subsets."
2. ANSI/TIA-606-B-2012 "Administrative Standard for Telecommunications Infrastructure (Currently Ratified) including all addenda and subsets."
3. ANSI-TIA-607-B-2012 "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises (Currently Ratified) including all addenda and subsets."
4. ANSI/TIA-758-B-2012 "Customer-owned Outside Plant Telecommunications Infrastructure Standard (Currently Ratified) including all addenda and subsets."

2. In addition, all Work shall fully comply with these specifications and related Drawings and all manufacturers' recommended installation practices.

Installer Qualifications: Cabling Installer must have qualified personnel on staff and shall have a thorough understanding of all standards referenced in this Section.

Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field-testing program shall be done by the project supervisor.

1. Installation Supervision: Installation shall be under the direct supervision of a Qualified Fiber Technician, who shall be present when any work of this Section is performed at Project site.
2. Testing Supervisor: Will be certified in the use of the Fiber Test equipment.

3. 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.

Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

Grounding: Comply with ANSI-J-STD-607-A.

1.9 DELIVERY, STORAGE, AND HANDLING

1.Test cables upon receipt at Project site.

2.Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
3. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

1. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

1. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PATHWAYS

1. General Requirements: Comply with TIA/EIA-569-B.

Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

Support brackets with cable tie slots for fastening cable ties to brackets.
1. J-hooks.

2. Straps and other devices.

2. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

   Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 TRUNK CABLE

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   Belden CDT Inc.; Electronics Division.
   1. Berk-Tek; a Nexans company.
   2. CommScope, Inc.
   3. General Cable
   4. Mohawk; a division of Belden CDT.
   5. Superior Essex Inc.

2. Description: 100-ohm, 4-pair UTP.

   Comply with ICEA S-90-661 for mechanical properties.
   1. Comply with TIA/EIA-568-C.1 for performance specifications.
   2. Comply with TIA/EIA-568-C.2, Category 6.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

      a. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.

3. Pull Trunk 12 Strand Shielded Outdoor Fiber to the existing Administration building 2nd floor fiber panels to the new 1st floor MDF in the new Health Building. Leave a 10' coil in the Administration building fiber cabinet and the new Health Building 1st floor MDF. Terminate all fibers with LC type fusion connectors in the new Corning Fiber Panel. Install an 12 port LC Adaptor Panel. All fiber and equipment to be Corning.

4. In conjunction with item 1 Pull a 25 pair Cat3 outdoor copper cable from the Administration Building telephone room in the lower level to the new MDF on the 1st floor of the Health Building. Terminate on new 110 blocks in the Administration Building Telco Room. Locate 110 block in Administration Building as close as possible to existing analog phone switch 110 blocks. **This needs to be coordinated with VU Telecom Personnel to determine the location of the existing 110 blocks that will be used for the new Health Building.** At the Health Building install a new 25 pair Outside Protector box in the MDF on the wall near the conduit entrance. Low Voltage Vendor should terminate the OSP cable and ground the sheath in the protector box as required. In the new Health Building install a 24 pair Cat3 Patch Panel on the new rack in the lower location. Run Cat3 patch cables from the new patch panel to the protectors in the protector box. **Jumpers for the analog lines will be provided and installed by the owner in the MDF. In the IDF the owner will provide any jumpers, or patch cords and installation required to provide analog phones in the new area.**

5. Both the fiber and the trunk cable can be pulled together in the existing VU conduit.

2.3 UTP CABLE HARDWARE

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   PANDUIT

2. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

3. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

   Number of Jacks per Field: One for each four-pair UTP cable indicated.

4. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

Patch Cords: Factory-made, 4-pair cables in lengths as required for proper connectivity at the patch panel; terminated with 8-position modular plug at each end. Excessive slack at the patch panel is not acceptable. Coordinate with Architect/Owner.

Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

1. Patch cords shall have color-coded boots for circuit identification.
2. Provide (2) per 4-pair installed.

2.4 OPTICAL FIBER CABLE INDOOR

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Corning Cable Systems.

2. Description: 12 Strand Single Mode, Corning Altos Loose Tube PN: 012EU4-T4700D20

3. Jacket:

   Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
   Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL FIBER CABLE HARDWARE

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Corning Cable Systems.
   2. PANDUIT.

2. Panels: Modular panels housing multiple-numbered, duplex LC cable connectors.

   Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria. Provide as required to house terminations of all fiber cable installed.

3. Patch Cords: Factory-made, dual-fiber cables in lengths as required for proper connectivity at the patch panel. Excessive slack at the patch panel is not acceptable. Coordinate with Architect/Owner. Provide two (2) for each end. Existing IDF and new IDF.

Cable Connecting Hardware:

Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with ANSI/TIA-568-C.3.

1. **All connectors will be LC type, utilizing fusion spliced pigtails**. Insertion loss is not more than 0.5 dB.

2.6 GROUNDING

1. Comply with ANSI/TIA-607-B-2012.

2.7 LIGHTNING PROTECTION

1. Provide proper lightning protection where applicable.

2.8 IDENTIFICATION PRODUCTS

1. Comply with ANSI/TIA-606-B-2012 and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.9 SOURCE QUALITY CONTROL

1. Factory test cables on reels according to ANSI/TIA-568-C.1

Factory test single mode optical fiber cables according to TIA/EIA-526-14-A and ANSI/TIA-568-C.3.

Cable will be considered defective if it does not pass tests and inspections.

Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

1. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 CLEANING AND PROTECTION

1. Protect system components from damage and deterioration during installation. Protect equipment from dust and debris during installation. After installation maintain equipment protection. Notify other trades of equipment sensitivity to dust and debris. Clean equipment upon final completion of Work.

Before final acceptance, clean system components.

3.3 WIRING METHODS

1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring methods may be used. Conceal raceway and cables except in unfinished spaces.

This Project is a non-plenum environment.

1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

   Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 INSTALLATION OF PATHWAYS

1. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-B-2012.

   Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

   Comply with ANSI/TIA-569-B-2012 for pull-box sizing and length of conduit and number of bends between pull points.

   Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

   Install manufactured conduit sweeps and long-radius elbows whenever possible.

   Pathway Installation in Communications Equipment Rooms:

   Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.

   1. Install cable trays to route cables if conduits cannot be in these positions.
   2. Secure conduits to backboard when entering room from overhead.
   3. Extend conduits 3 inches above finished floor.
   4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

2. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.5 INSTALLATION OF CABLES

1. Comply with NECA 1.

General Requirements for Cabling:

Comply with ANSI/TIA-568-C.1.

1. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

2. Group connecting hardware for cables into separate logical fields.

Separation from EMI Sources:

Comply with BICSI TDMM and ANSI/TIA-569-B-2012 recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

   Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

   Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

b. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

c. Electrical Equipment Rating Less Than 2 kVA: No requirement.
Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.6 FIRESTOPPING

1. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with ANSI/TIA-569-B-2012, "Firestopping."

Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 IDENTIFICATION

1. Identify system components, wiring, and cabling complying with ANSI/TIA-606-B-2012. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

Administration Class: 2.
1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

2. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with ANSI/EIA-606-B-2012 for Class 2 level of administration.

Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

3.8 FIELD QUALITY CONTROL

1. Testing Agency: a qualified testing agency to perform tests and inspections.

Tests and Inspections:

Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with ANSI/TIA-568-C.1.

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

    a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA68-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturers for channel or link test configuration.

Optical Fiber Cable Tests:

    b. Test instruments shall meet or exceed applicable requirements in ANSI/TIA68-C.2. Use only test cords and adapters that are qualified by test equipment manufacturers for channel or link test configuration.
    Link End-to-End Attenuation Tests:

        1) Horizontal and single mode backbone link measurements: Test at 1310 and 1550 nm. The max attenuation should be 0.5 per TIA-568. Max loss should be 0.3 per fusion splice or less. The typical loss is .05 (fusion).
        2) Attenuation test results for backbone links shall be less than 2.0 db. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA-568-C.1.

2. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

Remove and replace cabling where test results indicate that they do not comply with specified requirements.

End-to-end cabling will be considered defective if it does not pass tests and inspections.
Prepare test and inspection reports.

END OF SECTION 27 05 04

SECTION 27 05 05 – CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable trays.

B. Related Requirements:
1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
2. 270501 PATHWAYS FOR COMMUNICATIONS
3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
5. 270504 COMMUNICATIONS BACKBONE CABLING
6. 270505 CABLE TRAYS FOR COMMUNICATIONS
7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

1.3 DEFINITIONS

1. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
2. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
3. Provide: Furnish and install, complete and ready for the intended use.

1.4 ACTION SUBMITTALS

A. Product Data with Shop Drawings:

1. Product Data: For each type of cable tray.

a. Include data indicating dimensions and finishes for each type of cable tray indicated.

1) Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

1.5 LADDER RACK TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Chatsworth (CPI) or equal.

B. Description:

1. Configuration throughout Building: 18" x 4" mesh cable tray, with wire management dividers. CPI #10250-X18 or approved equal.
2. Configuration inside IT Room: 18" ladder cable tray.
3. Provide (2) 18" cable runway radius drops. CPI #12100-718.
4. Safety Provisions: Supply rubber end caps for all exposed ends.
5. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

1.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
B. Barrier Strips: Same materials and finishes as for cable tray.
C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

1.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1.

1.8 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA FG 1.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, grounding and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure.

F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200LB. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

G. Make cable tray connections using manufacturer's recommended fittings.

1.9 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

1.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

1.11 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 05

SECTION 27 05 06 – TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Requirements:
1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
2. 270501 PATHWAYS FOR COMMUNICATIONS
3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
5. 270504 COMMUNICATIONS BACKBONE CABLING
6. 270505 CABLE TRAYS FOR COMMUNICATIONS
7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

1.2 DEFINITIONS

A. Bonding - The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

B. Bonding Conductor for Telecommunications (BCT) - A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

C. Telecommunications Bonding Backbone (TBB) - A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB).

D. Telecommunications Grounding Busbar (TGB) - The interface to the building telecommunications grounding system generally located in telecommunications room. A common point of connection for telecommunications system and equipment bonding to ground, and located in the telecommunications room or equipment room.

E. Telecommunications Main Ground Busbar (TMGB) - A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications to the building service equipment (power) ground.

1.3 SUMMARY

1. This Section specifies the minimum requirements for a complete telecommunications bonding and grounding infrastructure and its interconnection to electrical systems and telecommunications systems.

2. Provide, install, and test a complete grounding (earthing) and bonding system for the telecommunications infrastructure. Telecommunications infrastructure components will achieve a common ground with the building's electrical system ground.
3. Reference the Grounding and Bonding Diagram in the associated drawings for a schematic of the minimum required connectivity.

    a. At minimum, the system shall bond together all racks/cabinets, cable tray, ladder rack, and other metallic components within each ER/TR, bond each TR to the ER, and bond the resulting grounding system with the Electrical grounding system.
    b. Label, Test, and document the entire system.

1.4 ACTION SUBMITTALS

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

1. Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include the following in operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at grounding connections.

1.6 QUALITY ASSURANCE

A. All installation practices shall be fully compliant with:

1. ANSI-J-STD-607-B-2011, "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises."
2. ANSI/NECA/BICSI-607, "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings."

B. All work shall fully comply with these specifications and related drawings and all manufacturers recommended installation practices.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING BUSBARS

A. General:

1. Locate TMGB and TGB at working height. Coordinate location with Engineer.

B. Telecommunications Main Grounding Busbar (TMGB):

1. Erico Electrical Products 1/4" thick x 4" high x 16" wide ground busbar assembly, Part Number B544A028 or approved equal.

C. Telecommunications Grounding Busbar (TGB):

1. Erico Electrical Products 1/4" thick x 2" high x 16" wide ground busbar assembly, Part Number B544A028 or approved equal.

D. Equipment rack busbar:

1. As specified in Division 27 "Communications Equipment Room Fittings."

2.2 BONDING CONDUCTORS

A. All bonding conductors shall be green insulated copper unless otherwise noted. Unless otherwise specified, size conductors as required by ANSI-J-STD-607-A. In plenum spaces, bare copper may be used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All work shall fully comply with these specifications and related drawings and all manufacturers recommended installation practices.

B. Provide all grounding and bonding as specified in the contract documents.

C. Ground electrical systems and equipment as required by code, utility, local ordinances, and requirements herein.

D. Bonding conductors shall be continuous and routed in a direct path to the point of termination.

E. All grounding busbars shall be isolated from the structure support by a 2-inch minimum separation using manufacturer's recommended insulating stand-offs and hardware.

F. Clean grounding busbars before terminating conductors.

G. Do not place busbars on exterior walls.

3.2 LABELING

A. Label the ends of all conductors.

B. Label conductors consecutively within each ER/TR 01 through "xx" with "xx" representing the last number in order.

C. Label all TGBs and the TMGB as identified on the Drawings and with the following:

WARNING!!!

IF THIS CONNECTOR OR CABLE IS

LOOSE OR MUST BE REMOVED

PLEASE CALL THE BUILDING

TELECOMMUNICATIONS MANAGER.

3.3 CONNECTIONS

A. Bond the TMGB to the service equipment (power) ground, typically located in the electrical entrance facility, using the most direct route possible to minimize conductor length. This will be provided by the Electrical Contractor.

B. Bond all TGBs to the TMGB using specified conductor.

C. Bond the following to the TMGB when present:

1. Telecommunications panelboard: Alternating Current Equipment Ground Bus (ACEG), if equipped, or its enclosure.
2. Building structural steel, if exposed. (Steel rebars of reinforced concrete are not required to be bonded.)
3. Metallic equipment racks.
4. Cable shields.
5. All metal raceways and cable trays for telecommunications cabling extending from the same room or space where the TMGB is located.
6. Floor tile ground tab if provided.
7. Others as identified on the Drawings.

D. Bond the following to the TGB when present:

1. Telecommunications panelboard: Alternating Current Equipment Ground Bus (ACEG), if equipped, or its enclosure.
2. Building structural steel, if exposed. (Steel rebars of reinforced concrete are not required to be bonded.)
3. TGBs within the same space if provided.

4. TBBs terminated on the same floor to other TGBs.
5. Metallic equipment racks.
6. Cable shields.
7. All metal raceways and cable trays for telecommunications cabling extending from the same room or space where the TMGB is located.
8. Floor tile ground tab if provided.
9. Others as identified on the Drawings.

E. Terminate Bonding Conductor for Telecommunications and TBB conductors with two-hole compression lugs.

F. Terminate all other conductors with one-hole compression lugs.

3.4 BONDING

A. General:

1. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

a. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
b. Make connections with clean bare metal at points of contact.
c. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

3.5 TESTING

A. Purpose:

1. The purpose of this test is to ensure proper grounding of the telecommunications system.

B. Test equipment:

1. Biddle Instruments, Megger DET2/2 Ground Tester or later approved model.

C. Testing guidelines:

1. The following testing guidelines apply to all test procedures and shall be followed to promote efficient and accurate testing:

a. Be sure all connections are tight. Loose connections will drastically affect the test results.
b. The test lead shall be No. 14 AWG, stranded, insulated copper conductor. The test lead shall be long enough to reach all TGBs from the TMGB. One test lead shall be used for all tests.

c. The test lead may be spooled. However, the Biddle meter may produce inaccurate or erratic resistance measurements if the quantity of cable on the spool is too great. If the meter behaves erratically, first try to perform the test in the "low current" setting. If the behavior persists, the lead should be unspoiled.
d. The current shall be set to "High."
e. The filter shall be set to "On."
f. The frequency shall be set to "150 Hz."
g. Connect Terminals C2 and P2 by a jumper wire (if not connected by the manufacturer).
h. Connect Terminals P1 and C1 by a jumper wire (if not connected by the manufacturer).
i. Once the test lead is attached to the meter it should not be removed as identified in the specific test procedure.

D. Reference test:

1. The reference test procedure is necessary to calibrate the test setup. Perform the reference test procedure before performing any test.
2. Record the reference value and subtract from all other measurements. If the length of the test lead is changed, perform and record new test data.

E. Reference test procedure:

1. Perform the test procedure as follows:

a. Connect one end of the test lead to Terminal C1 and the other end to Terminal C2.
b. Perform the Biddle Meter Resistance Test.
c. Record test lead resistance on the data sheet.
d. Disconnect the test lead from Terminal C1 ONLY. The test lead shall remain connected to Terminal C2 throughout the test.

F. Ground reference system continuity test:

1. The ground reference system shall be tested to validate the continuity and integrity of the interconnection of the system and the building's grounding electrode.

G. Ground reference system continuity test procedure:

1. Perform the test procedure as follows:

a. Remove all conductors except the TBB and the Bonding Conductors for Telecommunications from the TMGB and the TGBs.
b. Move the meter and test lead to the first TGB to be tested. Route and connect the test lead to the TMGB. The other end of the test lead should still be connected to Terminal C2 from the reference test. Connect a short test lead from Terminal C1 to the TGB to be tested.
c. Perform the Biddle Meter Resistance Test.
d. Record the resistance on the data sheet.

e. Attach the equipment bonding conductor from the panelboard located within the room to the TGB and repeat the test. Record the resistance on the data sheet.
f. Attach the equipment bonding conductor from the building steel (if applicable) and repeat the test. Record the resistance on the data sheet.

H. Leave the building steel and panelboard ground connected to this TGB. Repeat the test for all other TGBs.

END OF SECTION 27 05 06

SECTION 27 15 00 – COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Requirements:
1. 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
2. 270501 PATHWAYS FOR COMMUNICATIONS
3. 270502 SLEEVES AND SEALS FOR COMMUNICATIONS
4. 270503 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
5. 270504 COMMUNICATIONS BACKBONE CABLING
6. 270505 CABLE TRAYS FOR COMMUNICATIONS
7. 271500 COMMUNICATIONS COPPER HORIZONTAL CABLING

1.1 SUMMARY

A. Section Includes:

1. N/A.

B. Related Requirements:

1. N/A

1.1 DEFINITIONS

1. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
2. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
3. Provide: Furnish and install, complete and ready for the intended use.

1.1 WORK INCLUDED

A. Provide all labor, material, tools, and equipment for the complete installation of work called for in the construction documents.

B. The Contractor is directed to examine each and every section of the specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described that may relate to the provision of the work described herein. Materials and performance are specified herein that relate to these systems.

C. The use of proprietary or copyrighted names or reference to patented trade items with this specification or elsewhere in the Contract Documents is meant to establish a standard of quality and performance. All materials and equipment proposed for installation must meet or exceed all specified requirements.

D. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. Install one (1) Genspeed 6000E CAT6 data drop to each general data location. Terminate in CAT6E module in a multi-port recessed box. Test cable and label. Provide for two (2) CAT6E patch cables – one (1) each at the general data & patch panel ends.

B. Install one (1) Genspeed 6000E CAT6E data drop to each security camera location. Terminate in CAT6E module in a 1-port surface-mount box. Leave a 10' foot coil at each location and suspend from a 3/4" J-Hook. Label the box and the ceiling grid directly below the box. Test cable and label. Provide for two (2) CAT6E patch cables – one (1) each at the camera & patch panel ends. Existing security cameras shall be removed by contractor, re-used, & re-installed by Owner.

C. Install two (2) Genspeed 6000E CAT6E data drops to each wireless access point (WAP) location. Terminate in CAT6E modules in a 2-port surface-mount box. Leave 10' foot coils at each location and suspend from a 3/4" J-Hook. Label the box and the ceiling grid directly below the box. Test cables and label. Provide four (4) CAT6E patch cables – two (2) each at the WAP & patch panel ends. WAP's will be provided & programmed by Owner and installed by contractor. Note: WAP's shown on construction drawings are approximate locations. Coordinate a meeting with the Owner's representatives to discuss final locations.

D. Install one (1) Genspeed 6000E CAT6E data drop to the fire alarm control panel. Leave a 10' foot coil at the location and suspend from a 3/4" J-Hook. Terminate & test cable and label. Provide for one (1) CAT6E patch cable – at the patch panel end.

E. Install two (2) Genspeed 6000E CAT6E data drops to the power monitor mounted on electrical main switchgear. Leave a 10' foot coil at the location and suspend from a 3/4" J-Hook. Terminate & test cable and label. Provide for two (2) CAT6E patch cables – at the patch panel end.

F. Install two (2) Genspeed 6000E CAT6E data drops to the temperature controls panel in each mechanical room. Terminate in CAT6E modules in a multi-port recessed box – (1) inside the temperature controls panel & (1) in wall-mount box adjacent to panel. Coordinate exact location & height with temperature controls contractor. Test cable and label. Provide for two (2) CAT6E patch cables – at the patch panel end.

G. Where proposed cable trays won't be installed, provide J-Hooks – recommended by cable manufacturer - sized to support new cables. New cables will require support no less than 5'-0" apart in all locations.

H. In addition to all data drops shown on construction documents, Contractor shall provide for (5) additional data drops (maximum 295-ft lengths), to be incorporated into design during the construction duration.

I. Install 12 Strand Single Mode MIC Armoured Indoor fiber cables from (1) of the Room #214 racks to each of the other (3) racks.

J. Install 1U fiber panels with LC adaptor panels in each I.T. room rack.

K. Terminate trunk fiber with fusion LC connectors. Protect existing building feed fiber for duration of construction & re-use, terminating in (1) of the Room #214 racks.

L. Install (2) 19" Panduit Universal racks in each IDF. Ground to new buss bar tied to building MGN.

M. Equip racks as indicated on Detail Print.

1.4 SCOPE OF WORK – GENERAL

A. Coordinate a pre-construction meeting with the Owner's representatives to discuss project requirements, including cable routing, outages, general expectations, etc. Any issues shall be reported back to the Engineer, prior to construction.

B. Cables shall be installed within above-ceiling cables trays, as much as possible. Where no cable trays are present, provide J-Hooks – manufactured by Panduit - sized to support new cables. New cables will require support no less than 5'-0" apart in all locations.

C. All wiring/cabling shall be installed in a workmanlike manner, recessed in walls. Any wiring/cabling that must be exposed shall be installed within EMT conduit. No cable raceways are allowed – only EMT conduit. Contractor to paint EMT conduit to match adjacent wall/ceiling color. In addition, Contractor shall notify & receive permission from Owner, prior to installing said exposed wiring/conduit.

D. Low-Voltage Contractor shall coordinate sleeve- & cable tray-installation responsibility with Electrical Contractor prior to bid. Regardless of installation responsibility, Low-Voltage Contractor shall also coordinate sleeve & cable tray locations with Electrical Contractor prior to construction.

E. This is a Panduit Project. No substitutions on UTP cable or hardware. Refer to Approved Material List at the end of this section.

F. All CAT6E cabling shall be Genspeed 6000E (Enhanced), plenum-rated. Due to minimum order quantity, Genspeed 6500E cable is prohibited.

1.5 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Cabling identification products.
4. Grounding provisions for twisted pair cable.
5. Source quality control requirements for twisted pair cable.

1.6 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.7 COPPER HORIZONTAL CABLING DESCRIPTION

A. The horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing

protocols. A cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.

3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.8 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

1.9 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Project Manager & Installation Supervisor. The Low Voltage Project Manager & Installation Supervisor must be experienced in the installation of all systems called out in the low voltage bid documents. Changes on site without the approval of the Architect/Engineer or Owner's representative will be the responsibility of the Project Manager.

1.10 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.11 QUALITY ASSURANCE

A. Contractor Qualifications: Contractor must have personnel on staff familiar with BICSI installation codes and all equipment manufacturer's requirements.

1. Project Manager: Contractor responsible for this Section shall have a Project Manager who will oversee and be responsible for this Project. The Project

Manager shall have sufficient experience in this type of project to be able to lend adequate technical support to field personnel during installation, warranty period, and extended warranty periods/maintenance contracts. Provide the Project Manager's contact information to the Owner and Architect/Engineer prior to starting any installation work.

2. Installation Supervisor: Installation shall be under the direct supervision of the Installation Supervisor, and this person shall be present any time work of this Section is performed at project site. Provide the Installation Supervisor's contact information to the Owner and Architect/Engineer prior to starting any installation work.
3. The Project Manager and/or the Installation Supervisor will be required to attend all weekly progress meetings.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits. Any cables that prove to be defective after installation will be replaced at the expense of the Low Voltage Contractor.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.14 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Non-plenum: Type CMR complying with UL 1666.
2. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
3. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.3 CATEGORY 6E TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6E cable at frequencies up to 350 MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable; General Cable Corporation
2. Panduit

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

G. Jacket: color thermoplastic as follows:

1. To be determined by Owner.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable; General Cable Corporation
2. Panduit

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6e.

2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

3. Cables shall be terminated with connecting hardware of same category or higher.

D. Connecting Blocks:

1. 110-style IDC for Category 6e.
2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19" equipment racks.

3. Number of Jacks per Field: One for each four-pair cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

G. Patch Cables: Factory-made, four-pair cables in 36" lengths at the patch panel end and 10'-0" lengths at the workstation end; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

2. Patch cords shall have color-coded boots for circuit identification.

3. Provide (2) patch cables per horizontal cable installed, utilizing lengths listed above for bidding purposes. Confirm exact lengths with Owner's representatives prior to ordering. Excessive slack at the patch panel is not acceptable. Owner shall install patch cables at patch panel end, and Contractor shall install patch cables at workstation end. Coordinate with Owner representatives.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Standard: Comply with TIA-568-C.2.

3. Refer to 26 27 26 – Wiring Devices for specified plug colors/finishes.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Designed to snap-in to a patch panel or faceplate.

3. Standard: Comply with TIA-568-C.2.

4. Refer to 26 27 26 – Wiring Devices for specified jack colors/finishes.

J. Faceplate:

1. Two, Four, or Six port, vertical single gang faceplates designed to mount to single gang wall boxes. Faceplate port quantity is determined by the number of cables to be installed per drawing at each location. Any unused ports to be blanked off.

2. Eight, Ten, or Twelve port, vertical double gang faceplates designed to mount to double gang wall boxes. Faceplate port quantity is determined by the number of cables to be installed per drawing at each location. Any unused ports to be blanked off.

3. If an existing wall box is being used, the faceplate will be determined by the existing box size. Bid either single or two gang based on field conditions.

4. Refer to 26 27 26 – Wiring Devices for specified faceplate colors/finishes.

5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

6. Wall locations will require stainless steel plates with lugs for mounting phone.

a. Flush mounting jacks, positioning the cord at a 90-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum-rated cable.

2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270536 "Cable Trays for Communications Systems."

D. Contractor responsible for sleeve coring/installation shall be determined prior to bid, discussed between the Electrical Contractor and Low Voltage Contractor.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10 foot long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2 1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least 2 inches clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor. Contractor responsible for connections to electrical building ground shall be determined prior to bid, discussed between the Electrical Contractor and Low Voltage Contractor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: Class 2.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.

C. Cable Schedule: Demolish/remove any pre-existing cable schedules in equipment rooms and any other wiring closets. Install new cable schedule in a prominent location

in equipment room and any other wiring closets. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 6 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.

3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

b. Label each unit and field within distribution racks and frames.

c. Any above-ceiling installation requires that the existing ceiling grid be labeled with the MDF/IDF/Hub Room & patch panel number that the corresponding data drop is terminated in.

4. Identification within Connector Fields in MDF/IDF/Hub Room: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect twisted pair cabling jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for

compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Within (60) days of project completion, the Low Voltage Contractor will provide to the Owner & Architect/Engineer a complete set of electronic & paper CAD as-builts, showing approximate cable routing, rack details, and listing of drop locations showing MDF/IDF/Hub Room, patch panel, & port numbers. This will include (1) paper as-built and (1) flash drive with all the CAD as-builts. Coordinate a meeting with the Owner's representatives to discuss final requirements.

H. Within (60) days of project completion, the Low Voltage Contractor will provide (2) sets of test results – (1) to the Owner's representative, and (1) to the Architect/Engineer. These should be reviewed by the Low Voltage Contractor's Project Manager and signed off in a cover letter, that all cables tested and passed based on BICSI TIA 568-C1 standards.

I. The Low Voltage Contractor will provide a (1) one-year warranty on parts and labor to replace any defective cable or hardware. This warranty will only pertain to product defects and will not apply in the case of damage to the cable or hardware by others after test results have been provided to Owner.

The Vincennes University Cabling Standard below shall supersede any other construction specification.

Please use the following list of standards for any network cabling installations or upgrades. If you have any questions regarding any of these, please contact the Management Information Center.

Panduit parts and numbers:

CPP48FMWBLY 48-port modular patch panel

CPP24FMWBLY 24-port modular patch panel

CJ688TGRD	Red modular jack	Use for sensitive or protected equipment
CJ688TGOR	Orange modular jack	Use for standard data devices (computers)
CJ688TGYL	Yellow modular jack	Use for AV equipment
CJ688TGGR	Green modular jack	Use for Wi-Fi equipment
CJ688TGPR	Purple modular jack	Use for cameras
CJ688TGIW	White modular jack	Use for voice-specific devices
CJ688TGBK	Black modular jack	Use for third party devices (Laerdal)

At the current time the current cabling standard is CAT6, plenum-rated cable. No need to go with the higher cost CAT6A cabling at this time.

CAT6 cable colors to match the jacks listed above:

Red, Orange, Yellow, Green, Blue, Purple, White, Black

Red cable and jacks for critical equipment such as servers

Orange cable and jacks for lab and employee computers.

Yellow cable and jacks for televisions and other displays.

Green cable and jacks for wireless access points.

Blue cable and jacks for HVAC temperature controls.

Purple cable and jacks for security cameras.

White cable and jacks for window shades & in-room devices.

Black cable and jacks for third party devices (Laerdal).

Cable Handling
Length
The maximum horizontal cable length is 90 m (295 ft); 10 m is allowed for cords in the work area and for patch cords or jumpers in the telecommunications closet.

The maximum backbone cable length is typically 90 m (295 ft), but this number now depends on media and applications. A 90 m length assumes that 5 m (16 ft) are needed at each end for equipment cables connecting to the backbone.

Pulling Tension
Maximum pulling tension for a 4-pair horizontal cable is 25 lbf. Excessive pulling tensions may occur during installation. Once the damage is done, reversing the effect may not be sufficient enough to correct the problem; in this scenario, cable replacement is recommended. Intermediate cable pulls within the overall cable run may be necessary to avoid exceeding the maximum pulling force.

Minimum Bend Radius
Minimum bend radius can be calculated by multiplying the outside diameter (OD) of the cable by 4. For example, if you have a cable with an OD of .250, the minimum bend radius can be determined this way:

4 x .250 = 1"

CAUTION: Exceeding the minimum bend radius can distort cable geometry and result in degradation of transmission performance.

Repositioning the cable to the proper bend radii may not correct the fault. Once the damage is done, the best option is to replace the damaged run.

There are two common places where exceeding the minimum bend radius may occur:

- At the **workstation wall outlet**. After the cable is terminated, too often the remaining cable is jammed into the wall outlet (or worse, wrapped around itself and shoved into the outlet). A better practice is to gently work the excess cable length back through the wall outlet into the wall.

- At the **wiring closet** and during **cable routing** to the terminal block or patch panel. Prior cable placement practices may have encouraged making the cable appear as form fitting or tight against the routing structure (cable tray or rack) as possible. A better practice is to incorporate gently sweeping curves along the cable path, avoiding sharp bends or changes in direction. Every effort should be made to ensure the path the cable follows has smooth, gradual sweeps at any transition point.

Overstressing
Eliminate cable stress caused by tension in suspended cable runs and tightly cinched cable bundles.

Excessive cable loading or stress can also occur if a cable is incorrectly suspended in a cable run. A recommended cable support spacing is 48" to 60" centers.

Avoid twisting cables during installation. Excessive twisting may result in distortion of cable geometry and, in severe cases, tears in the jacket.

In addition to the above guidelines extracted from ANSI/TIA-568-C, It is strongly recommended to follow these supplementary installation tips:

- Do not walk or step on high-performance cable. Do not run over high-performance cable with hand trucks or forklifts. This can exert excessive force on the cable, distorting the geometry and/or crushing the pairs, resulting in electrical shorts.
- Do not use staples, either from a staple gun or mounting in a traditional manner with a hammer. Staples can exert excessive force on the cable and distort the pair geometry.
- Nail-on clamps or Velcro straps all offer acceptable cable-management techniques without compressing the cable.
- Do not run cable near sources of heat; this may negatively impact cable attenuation.
- Maintain a 6" minimum spacing between cables and sources of EMI, such as fluorescent lights or unshielded power lines

Termination
The installer must be acquainted with the connector manufacturer's installation instructions. The correct tools, wire layout and untwist length are critical, especially in Category 6 installations. Modular jacks usually have the pair color code marked on the jack. The color code can be either T568A or T568B wiring methods. Maintain the same pin-to-pair combination throughout the installation. Changing pin-pair assignment can result in crossed pairs. Modular jacks and cross-connect blocks employ IDC connectors to complete the circuit between the cable and the hardware. The manufacturer will recommend the tools needed to terminate the cable.

- Terminate with connecting hardware of the same category or higher. Any link that has substituted a lower-category component is automatically classified to that lower category.
- The maximum allowable amount of untwisting during cable termination to connecting hardware is 0.5" for Category 5e and Category 6 cables. Exceeding the recommended length of untwisting may cause performance problems. The same techniques should be employed when terminating cross-connect blocks. Maintaining jacket integrity to the point of termination aids in maintaining cable geometry and NEXT isolation from adjacent cable pairs.
- When terminating F/UTP cable, follow the same guidelines as listed above. Additionally, termination of the thin foil shield and drain wire are important to maintain shield continuity and shielding effectiveness from the cable to the connector. The connector manufacturer's installation instructions should be followed for shielded cable termination.
- Bridged taps and splices are not permitted as part of copper horizontal cabling requirements.

Examples of installations where industry and University standards are followed:

PANDUIT
PANDUIT
PANDUIT
PANDUIT

A
PATCH PANEL 'A'
PANDUIT
B
PATCH PANEL 'B'
PANDUIT
C
PATCH PANEL 'C'
PANDUIT
D
PATCH PANEL 'D'
PANDUIT
PANDUIT
PANDUIT

END OF SECTION 27 15 00

SECTION 28 00 13 –ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 CONDITIONS

A. This document includes a general description, functional requirements, operational characteristics, and criteria for the Access Control System (ACS).

1.2 GENERAL REQUIREMENTS

A. This shall document the general description, functional requirements, operational characteristics, and criteria for the Access Control System (ACS).

B. The Codes and Regulations listed below form a part of this specification to the extent referenced. Work shall be performed in accordance with the applicable international, federal, state, and local codes or standards current at the commencement of installation. The following list summarizes applicable standards:

1. UL 294, UL 1076, ULC
2. CE
3. FCC – Part 15, Part 68
4. NFPA 70, NEC
5. IEEE, RS 170 variable standard
6. Microsoft® Open Database Connectivity (ODBC) interface)
7. ISO Software Coding Standards
8. RoHS

C. Where more than one code or regulation is applicable, the more stringent shall apply.

D. Cable installation, identification and termination shall be performed in addition to the applicable codes above.

1.3 SCOPE OF WORK

A. Furnish & provide for complete installation of new access control system, including all card reader devices, above-ceiling controllers, front end components, control panels, & all associated wiring/conduit back to new front-end computer.

B. Owner shall provide & set up new front-end computer. Contractor shall install access control system on this new computer, and provide for all new programming.

C. Provide for a fully-functioning access control system at completion of project, operating as per Owner's wishes.

D. Provide for a 2-hour training session with Owner's representatives. Coordinate training session schedule with Owner.

E. Wiring shall be installed within above-ceiling cables trays, as much as possible. Where no cable trays are present, provide J-Hooks, using RS2 Technologies-approved manufacturer, sized to support new wiring. Wiring will require supports no less than 5'-0" apart in all locations.

F. Provide for (2) additional card readers & controllers, of each type & model utilized on the project, to Owner for spare part stock.

1.4 ACCESS CONTROL SOFTWARE & DATABASE MANAGEMENT

A. Access Control Software shall be **Access It! Universal.NET from RS2 Technologies LLC**. The ACS shall use a single seamlessly integrated Microsoft SQL relational database for all functions utilizing a fully multi-tasking multi-threading Microsoft Windows operating system. No substitutes allowed.

1. Annual Software Maintenance Fees shall not be acceptable. Access Control Software shall be supported by the manufacturer to the authorized reseller at no annual fee. The current major version of the released version and the previous released version of the software and all sub-versions of the current and previous major version shall be supported.

2. Reader License charges. There shall be no Reader License Fees, software having Reader License Fees based on the number of readers supported by the software package shall be unacceptable.

3. Upgrades or expansion of the ACS to a larger size system in scale shall not require installation of a different and or new ACS application or require the administrator / operator to learn a different and or new interface from the previous version.

4. The ACS shall be written using recognized standard software coding techniques. The ACS shall be written to support multiple languages without re-engineering. The ACS software shall be written to Microsoft's published standards for User Interface Design, Secure Coding Practices and Database Implementation Guidelines.

5. The ACS software developer shall be a Microsoft Certified Independent Software Vendor.

6. The ACS shall support N-Tier architecture where the expansion of the system architecture will allow for end-user deployment based upon their system architectural needs. The ACS shall allow but not require the separation of the database, application server, web server, and client interface. The ACS shall

require that all connections to the database are performed through a trusted link from the client or internet browser interface.

7. The ACS shall support Centralized distribution (publishing) of applications using Windows Terminal Server, Citrix, or utilizing IIS for the web client using a standard internet browser such as Internet Explorer, Mozilla Firefox, Google Chrome, Apple Safari, and/or by means of a mobile computing platform using a Tablet PC, PDA device, or Smart Phone.

8. The ACS architecture shall support Microsoft Windows Clustering, Hot-Standby, Fault Tolerant Servers, Fault Tolerant Hot Standby Servers, and Virtual Servers.

9. The ACS shall only be able to connect to and interface with data sources utilizing a Windows Service.

10. The ACS shall require the default Administration password be changed on the first login after installation of the ACS software package.

11. The ACS shall be capable of importing or updating Cardholder data using the following source types.

    a. Microsoft Access
    b. Microsoft Excel
    c. Microsoft SQL Server
    d. Active Directory
    e. ASCII Text (delimited file)

12. The ACS (RS2 Access It! Universal.NET) shall support:

    a. 1000 System Control Panels (SCP)
    b. Support for 256 Tasks per SCP
    c. 64,000 Access Control Readers, 64 readers per SCP.
    d. 512,000 Inputs, 512 per SCP
    e. 512,000 Outputs 512 per SCP
    f. Supports multi-drop OSDP readers with EP/LP SIO devices.
    g. Unlimited Cardholders
    h. Multiple Cards per Cardholder
    i. 32,737 Access Levels
    j. 128 Access Levels per Card
    k. 255 Timezones, with 12 start/stop intervals each
    l. 255 Holidays, across 8 Holiday Groups/Types
    m. Elevator Control using 64 Floors with 255 Floor Codes
    n. Support for KONE destination dispatch elevator control.
    o. Support for OTIS destination dispatch elevator control
    p. Support for Schindler destination dispatch elevator control.
    q. Anti-Passback with Occupancy Counting
    r. Virtualization Support
    s. Video Integration Support
    t. Zenitel Intercom integration support.
    u. Biometric Integration Support
    v. Web Client / Thin Client Support
    w. Fully Integrated Graphical Mapping (Floor Plans with Active ICONs)

x. Definable Report Support, with the ability to Hyperlink recorded video directly from with-in a Report to play back recorded video in a single step operation.
y. Workstation can be used for other tasks while reports are being generated.
z. User Definable Macro Support.
aa. Macro Utilization report.
bb. Calendar display on Macro screen.
cc. Outlook ICS files may be imported for Macro Schedules
dd. Macros may be set to automatically delete after scheduled execution.
ee. Macros may be pinned to the Ribbon Bar for immediate access. Pinned Macros may have a friendly (custom) icon assigned on the Ribbon Bar.
ff. Macros may be placed on Graphic Floor Plans (Maps) for immediate access.
gg. Unassigned Access Level Interval and Timezone report assists with system organization and clean up.
hh. Windows Authentication allows log in without entering separate password.
ii. Diagnostics permits viewing all Access It! Universal.NET messages in Windows Event Viewer.
jj. System Status screen has direct links to filtered views such as Unlocked Doors, Active Cards, Installed SCPs, SIOs, Readers, Inputs, Outputs, Unlocked Doors, and other System Status Categories.
kk. Ability to create a mandatory custom drop down database field for cardholder information
ll. Advanced Hardware Filter Views.
mm. Dynamic Search capabilities
nn. Lifesafety power integration

M. Lock Integration support for:

a. ASSA ABLOY – IP enabled, IWP and Aperio
b. Allegion – Schlage AD-300/301, AD-400/401 and Engage Platforms
c. Dormakaba – Best WiQ and IDH Max Support
d. Salto – Sallis SX4 & SVN (The SX4 line and the Salto Virtual Network - Data on Card line).

N. The ACS shall support:

a. Multiple Sites, (Partitioning, or Segmenting)
b. 1000 System Control Panels (SCP)
c. Support for 256 Tasks per SCP
d. 64,000 Access Control Readers, 64 readers per SCP.
e. 512,000 Inputs, 512 per SCP
f. 512,000 Outputs 512 per SCP
g. 8Supports multi-drop OSDP readers with EP/LP SIO devices.
h. Unlimited Cardholders
i. Multiple Cards per Cardholder
j. 32,737 Access Levels
k. 128 Access Levels per Card
l. 255 Timezones, with 12 start/stop intervals each
m. 255 Holidays, across 8 Holiday Groups/Types
n. Elevator Control using 64 Floors with 255 Floor Codes
o. Support for KONE destination dispatch elevator control.

p. Support for OTIS destination dispatch elevator control
q. Support for Schindler destination dispatch elevator control.
r. Anti-Passback with Occupancy Counting
s. Virtualization Support
t. Video Integration Support
u. Zenitel Intercom integration support.
v. Biometric Integration Support
w. Web Client / Thin Client Support
x. Fully Integrated Graphical Mapping (Floor Plans with Active ICONs)
y. Definable Report Support, with the ability to Hyperlink recorded video directly from with-in a Report to play back recorded video in a single step operation.
z. Unlimited User Definable Macro Support per site.

O. Lock Integration support for:

a. ASSA ABLOY – Wi-Fi; POE; IWP and Aperio locks.
b. Allegion – AD-300, AD-301 Hardwired Locks; AD-400 AD-401 Wireless Locks; NDE Cylindrical Lock; LE Mortise Lock; RM/RU exit Devices; Control Deadbolt or Interconnected locks.
c. Dormakaba – Best WiQ and IDH Max Support
d. Salto Sallis, SX4 & SVN

P. ACS Software and Field Hardware Warranty. The ACS Software shall be warranted for a period of 90 Days from the date of shipment from the manufacturer to be free of defects and will function in substantial accordance to the published specification.

a. ACS Field Hardware shall be warranted for a period of three (3) years from the date of shipment from the manufacturer, will be free from defects and will function in general accordance with the product specifications.
b. ACS Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third-party warranties to the owner. Specific third-party warranty details, terms and conditions, remedies and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the SMS field hardware or computers and are purchased directly from the SMS manufacturer. Examples may include but not be limited to; Credential Printers, Reader Heads, Biometric Devices, Computers etc.

Q. The Access Control System shall use one of the following Operating Systems, Windows 8 Professional, Windows 8.1 Professional, Windows 10 Professional, Windows Server 2008 R2, Windows Server 2012, Windows Server 2012 R2, Windows Server 2016. Other Operating Systems such as but not limited to - Windows Home editions, Linux, Unix, Sun, or Apple shall not be acceptable.

a. The ACA shall use Microsoft SQL Server 2017 Express, Standard or Enterprise Editions as the database engine. SQL Server 2017 Express shall be included with Access It! Universal.NET CD-ROM, SQL Server 2016 Express, Standard, or Enterprise Editions, SQL Server 2014 Express, Standard or Enterprise Editions,

SQL Server 2012 R2, Express, Standard, Enterprise Editions are supported. Other Substitutions shall not be acceptable.

U. The ACS shall be capable of utilizing a Web client. The Web client shall be capable of being utilized via any standard Browser to include but not limited to Microsoft Internet Explorer, Mozilla Firefox, Google Chrome, Opera, Apple Safari, IOS Browser, and Android Browser. The Web client shall be device aware such that it shall display according to the device it is being used from with larger buttons on a mobile device such as a Tablet or Phone. The Web client shall require the User to log in and shall utilize User Groups to allow commands / functions available to the User if at a Desktop (i.e. change reader mode, find, a cardholder/card, interact with cardholder/card, execute a Macro, change an Access Level,

R. ACS Software Interface

a. The ACS Software shall be Microsoft Windows compliant having a Microsoft "Outlook" type structure, having the following features / functions:
b. The ACS shall display a "Ribbon Bar" (Tool Bar) at the top of the screen containing buttons for the functions which may be utilized pertaining to the current selected Menu / screen.
c. When the Advanced Window Control is enabled, the ACS shall allow all screens to be moved independently. The ACS shall support multiple monitors when Windows is utilizing an Extended Desktop and has multiple display monitors present.
d. The ACS shall permit advanced device commands to be shown or to be hidden at the option of the user.
e. The ACS shall have a user selectable setting to determine the number of Traced Card/Cardholder/Reader events to pull from the database for display in the tracking screen on startup from 1 – 100.
f. The ACS shall permit Users to select that screens to be displayed in a Tab format (Advanced Window Control) permitting a User to quickly and easily move between screens without requiring one screen to be closed prior to moving to the next screen.
g. The ACS shall permit a User to relocate Tabs and to separate Tabs (screens) for most efficient use.
h. The ACS shall be capable of allowing a User to only work with a single Site (Segment) at a time or to work with multiple Site(s) (Segments) at the same time, as the User's password permissions dictate.
i. The ACS shall be capable of permitting the use of "Non-Modal dialogs" via a menu selectable check box.
j. The ACS shall be capable of tracking Cardholders, Cards, or Readers in a separate Tracking Screen\Window for those items being Tracked (watched).
    1) The ACS shall be capable of permitting a User to set the number of historical Tracking events to search for and display when the workstation is started (signed in/logged in) allowing the User to immediately view the last X (up to 100) Tracked / Watched item events without creating and running a report.

S. The ACS shall have a User-selectable real-time "Mustering" screen. This screen shall permit the User to select the "Ares(s)" of interest, the Refresh Interval (which will continue to update the selected area(s) of interest every X selected seconds, Omit cards not used in X hours from being shown, and Print Reports from the Mustering screen.

T. The ACS shall be capable of having Digital Video Recording / Network Video Recording integrations.

U. Biometric Integration
   a. Allegion – HandKey
   b. Suprema BioConnect – FingerPrint / Facial Recognition
   c. SAFRAN Morpho – FingerPrint
   d. ZKAccess – FingerPrint
   e. Invixium – FingerPrint/Fingervein/Facial Recognition

V. Wireless and POE Locksets
   a. Allegion
   b. Assa Abloy
   c. Dormakaba
   d. Salto
   e. Simon Voss

W. Intrusion Detection System Integration
   a. Bosch (7412 and 9414 versions G, GV2, GV3 (8.05 and 8.13) and GV4, and B series panels)
   b. DMP (XR-100N, XR-150N, XR-500N, XR-550N versions 100 and 200)

X. Mobile Access Control / Mustering
   a. Telaeris - XpressEntry

Y. Destination Dispatch Elevator Control
   a. Otis – Compass Destination Entry
   b. Kone Destination Dispatch
   c. Schindler PORT Technology
   d. Thyssenkrupp destination dispatch

Z. Data Matrix and QR barcodes are supported.

AA. Eyelock Iris integration.

AB. Access It! Universal.NET RESTful web API with API keys, available.

AC. Operating Modes, permitting real-time changes to access levels. (Operating Mode, may be modified manually using keyboard input, Operating Modes may be changed as the trigger to a Task, or be changed as a Step (result of a Task).

1.5 ACCESS CONTROL SYSTEM HARDWARE

A. The ACS shall communicate with, monitor, and use open architecture System Control Processor (SCPs), which shall support 64 controlled openings per, EP – 1502, EP – 2500, EP – 4502 EP-4502 with Auxiliary Authentication Module (AAM), the Lp4502, LP2500, LP1502, LP1501 SCPs. The EP – 1501 and LP-1501 (SCP) shall support a total of 17 openings. The ACS shall be capable of communicating with a minimum of 1,000 SCPs concurrently for a minimum of 64,000 controlled openings. The ACS shall not employ reader licenses which limit the number of Readers the ACS shall control. The ACS shall be capable of communicating with the SCPs using Hardwire (direct RS-232, or RS-485), Dialup modem using POTS (Plain Old Telephone system), and TCP/IP network communications. Each SCP shall be capable of maintaining in its memory a Real-time clock, 256 Holidays, 128 TimeZones each having 12 start\stop Time Intervals, 32,000 Access Levels, 256 Tasks (predefined routines with 256 steps per Task), 16 Card Formats (up to 19 digit card codes, 16 Facility (Site) codes, supports Open Supervised Device Protocol (OSDP) multi-drop support with series 3 Mercury hardware, supports Anti-Passback (areas, hard, soft, timed, nested), occupancy count rules, device configurations for the devices (Readers, Inputs, Outputs) controlled by the SCP, and a minimum of 50,000 event transactions if the SCP is unable to communicate to the ACS, the SCP stores Card numbers for entry decisions.

B. System Input Output (SIO), Reader Interface Modules (RIM), such as the MR-50 single (opening) reader interface, MR-52 dual opening or single opening with in out reader interface control, and MR-51E single opening control supports dual readers for IN \ OUT control or the Series 3 MR-50, MR-52, MR-62e.

C. System shall have the ability to make individual reader(s) beep when the reader has a forced/held/pre-alarm state, via a selectable check box.

D. The ability to designate a Responsible Person on the Auditing screen, and display that column on the reader's grid.

E. System Input Output (SIO), 16 dry contact Input modules with 2 Form C output relays, and 16 form C relay Output modules, such as the MR-16IN, or the MR-16OUT or the series 3 MR-16IN, MR 16-OUT, SIO devices.

F. The ACS shall also have the capability to integrate \ communicate with wireless \ IP locksets, Intrusion Systems, and Biometrics.

G. The ACS shall be capable of utilizing PVC/Composite badge printer having a Windows compliant \ capable Windows Driver for the Operating System being utilized for the ACS Workstation Software. The ACS shall utilize standard Dot Matrix, Laser, and Ink jet printers for report purposes having a Windows Driver for the workstation the printer is connected to.

1.6 ACCESS CONTROL HARDWARE DEVICES

A. Card Readers:

1. Schlage MT-15-485-BK

B. Controllers

1. RS2 LP1502-S3
2. RS2 MR-52-S3

1.7 ACCESS CONTROL INTERFACES

A. The ACS shall be capable of having the following video surveillance interfaces at a minimum.

1. CCTV – The ACS shall have the ability to send an ASCII command via RS-232 to a video switcher.
2. DVR / NVR – The ACS shall have the ability to have an interface to authorized DVR / NVR units listed below, to pull live video or recorded video to the ACS. The ACS shall not store or manipulate the video, the ACS shall only request the video stream, in order to maintain any watermarking, and or chain of custody for legal uses.
3. American Dynamics
4. Avigilon (Avigilon Control Center version Client\Server v.7.x)
5. Bosch
6. Digital Watchdog (Digital Watchdog Spectrum 2.5 and up)
7. eXacq (eXacqVision Enterprise VMS-Hybrid Z Server/Client 8.8)
8. Genetec (Omnicast 5.x)
9. HIKvision
10. March networks (9000/8000 Series Hybrid NVRs Command VMS)
11. Milestone (Milestone XProtect XProtect 2019)
12. Milestone – MIPS Bi-directional Integration
13. OnSSI (OnSSI Ocularis PRO / Ent / ULT 4 and 5)
14. Panasonic
15. Pelco (Digital Sentry DSNVS, DSSRV, Endura)
16. Salient Systems (CompleteView 20/20)
17. VideoInsight

1.8 ACCESS CONTROL IDENTIFICATION MANAGEMENT SYSTEM

A. The ACS shall have a seamlessly integrated ID Management System module capable of producing PVC credentials.

B. The ACS ID Management System module shall use the same SQL database as the ACS uses.

C. There shall be a minimum of 32 User Definable database fields for Cardholder Credential purposes. The ACS ID Management module shall have the capability to add an unlimited number of additional User Definable fields to the database.

D. Each ACS ID Management module, User definable field shall be capable of being a Text field, Pull down list field, Date Combo field, or Text field with Required entry.

E. The ACS ID Management module shall have the capability to capture Photo's from a web (USB) camera having a suitable windows driver, a camera or scanner with a TWAIN interface, import images from BMP, JPG, JPEG, GIF, and PNG file types.

F. The ACS ID Management module shall have the capacity to have an unlimited number of Badge forms (templates). Badge forms (templates) may contain graphics, any and all Cardholder data fields, static text, photo (image), and may contain those items only when specific criteria is met as defined using a "IF" statement. Fields shall be capable of being printed as a Barcode when the Badge Type (template) is printed or viewed.

G. The ACS shall be capable of integrating with the following Visitor Management Systems.
1. STOPware
2. HID - EasyLobby
3. SPLAN
4. SoloInsight
5. Savance

1.9 DOOR/CARD READER SEQUENCE OF OPERATION

A. Facility Entry/Exit Doors with ADA Actuator:

1. Facility Open Operation:

a. Door is normally closed & unlocked. Both ADA actuator buttons are enabled at all times. Pushing either enabled ADA actuator button will cause the automatic operator to momentarily open the door. Free egress at all times.

2. Facility Closed Operation:

a. Door is normally closed & locked. Both ADA actuator buttons and automatic operator are normally disabled. Activating card reader will momentarily unlock the door and will momentarily enable actuator button/automatic operator. Pushing the ADA actuator button at this time will cause the automatic operator to momentarily open the door. All components will return to the normal Facility Closed state soon (length of time to be determined) after the card reader activation. Key will also unlock the exterior door for entry during Facility Closed operation. Free egress at all times.

B. Facility Entry/Exit Doors without ADA Actuator:

1. Facility Open Operation:

a. Door is normally closed & unlocked. Free egress at all times.

2. Facility Closed Operation:

a. Door is normally closed & locked. Activating card reader will momentarily unlock the door. Components will return to the normal Facility Closed state soon (length of time to be determined) after the card reader activation. Key will also unlock the exterior door for entry during Facility Closed operation. Free egress at all times.

C. Interior Doors with ADA Actuator:

1. Facility Open Operation: (All interior doors shall always be in Facility Open operation.)

    a. Door is normally closed & locked. Both ADA actuator buttons and automatic operator are normally disabled. Activating card reader will momentarily unlock the door and will momentarily enable actuator button/automatic operator. Pushing the ADA actuator button at this time will cause the automatic operator to momentarily open the door. All components will return to the normal Facility Open state soon (length of time to be determined) after the card reader activation. Key will also unlock the interior door for entry. Free egress at all times.

D. Interior Doors without ADA Actuator:

1. Facility Open Operation: (All interior doors shall always be in Facility Open operation.)

    a. Door is normally closed & locked. Activating card reader will momentarily unlock the door. Components will return to the normal Facility Open state soon (length of time to be determined) after the card reader activation. Key will also unlock the interior door for entry. Free egress at all times.

END OF SECTION 28 00 13

SECTION 28 31 00 – FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contractor shall provide for complete fire detection/alarm system – fully operational – including devices, wiring, alarms, to meet all applicable jurisdictional requirements, including State of Indiana and the City of Vincennes.
   1. Only Johnson Controls, Inc. and Innovative Fire & Security in Evansville, IN are approved fire alarm contractors, by Owner.

B. Fire alarm system design and installation, including all components, wiring, and conduit.

C. Transmitters for communication with supervising station.

D. Maintenance of fire alarm system under contract for specified warranty period.

1.2 RELATED REQUIREMENTS

A. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.

B. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

C. Section 14 20 10 - Passenger Elevators: Elevator systems monitored and controlled by fire alarm system.

D. Section 23 33 00 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.3 REFERENCE STANDARDS

A. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (R2008).

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 72 - National Fire Alarm Code and Signaling Code; 2010.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Evidence of designer qualifications.

C. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:

1. Copy (if any) of list of data required by authority having jurisdiction.
2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
4. System zone boundaries and interfaces to fire safety systems.
5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
11. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
12. Certification by Contractor that the system design complies with the contract documents.

D. Evidence of installer qualifications.

E. Evidence of instructor qualifications; training lesson plan outline.

F. Evidence of maintenance contractor qualifications, if different from installer.

G. Inspection and Test Reports:

1. Submit inspection and test plan prior to closeout demonstration.
2. Submit documentation of satisfactory inspections and tests.
3. Submit NFPA 72 "Inspection and Test Form," filled out.

H. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:

1. Complete set of specified design documents, as approved by authority having jurisdiction.

2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

I. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:

1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

J. Closeout Documents:

1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Maintenance contract.

K. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.

1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
2. Installer Personnel: At least 2 years of experience installing fire alarm systems.

3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.

C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.6 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 5 years after date of Substantial Completion.

C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire Alarm Control Units - Acceptable Providers:

1. Innovative Fire
2. Siemens.

B. Substitutions: See Section 01 60 00 - Product Requirements.

1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with contract documents.

2.2 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:

1. Provide all components necessary, regardless of whether shown in the contract documents or not.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:

a. The Americans With Disabilities Act (ADA).
b. The requirements of the local authority having jurisdiction.
c. Applicable local codes.
d. The contract documents (drawings and specifications).

e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.

4. Evacuation Alarm: Single smoke zone; general evacuation of entire premises.
5. Combined Systems: Do not combine fire alarm system with other non-fire systems.

B. Supervising Stations and Fire Department Connections:

1. Remote Supervising Station: UL-listed central station under contract to facility.
2. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.

C. Circuits:

1. Initiating Device Circuits (IDC): Class B, Style A.
2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:

1. Initiating Device Circuits: Minimum 25 percent spare capacity.
2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
3. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:

1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.3 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:

1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Manual Station.
4. Fire Standpipe System.
5. System Smoke Detector.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

1. Sprinkler water flow.
2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.

C. Elevators:

1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.

D. HVAC:

1. Area Smoke Detectors/Duct Smoke Detectors: Close dampers individually by associated smoke detector/duct smoke detector activation; shut down air handlers indicated.
2. Provide return air duct smoke detector on all fan coil units greater than or equal to 2000 cfm. If no return air ductwork is installed at these fan coil units, install duct smoke detector in supply air ductwork.
3. Provide supply & return air duct smoke detectors on all MAU's & AHU's greater than or equal to 15,000 cfm. If no return air ductwork is installed at these MAU's & AHU's, install duct smoke detector in supply air ductwork only. Provide adequate quantity of duct smoke detectors in large ducts, as required per Code.
4. Fire/smoke and smoke dampers in this building are provided by Mechanical Contractor. These dampers have a 120V electric actuator.
5. Provide 120V power from nearest power panel to power all fire/smoke dampers. Connect as many dampers to each branch circuit so the circuit is loaded to no more than 70% of its capacity.

E. Doors:

1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.

2.4 COMPONENTS

A. GENERAL:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. FIRE ALARM CONTROL PANEL (FACP)

1. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
2. The following FACP hardware shall be provided:
   a. FACP to have dual dial-out capability. For bid purposes, provide for cellular/IP dialer. Confirm preferred dual dial-out methods with Owner.
   b. Power Limited base panel with red cabinet and door, 120 VAC input power.
   c. 10,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
   d. 10,000 points of Network Annunciation at FACP Display when applied as a Network Node.
   e. 10000 points of annunciation where one (1) point of annunciation equals:
      1) 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
      2) 1 LED on panel or 1 switch on panel.
   f. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.

g. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
h. One Auxiliary electronically resetable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
i. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
j. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
k. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
l. The FACP shall support (6) RS-232-C ports and one service port.
m. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
n. Programmable DACT for either Common Event Reporting or per Point Reporting.
o. Service Port Modem for dial in passcode access to all fire control panel information.

3. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
4. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands. 4100-315 Specifications

C. AUTOCALL SYSTEM INTERFACE

1. When a fire alarm system using existing Autocall XA loop devices requires expansion FACP shall be capable of interfacing to the XA loop via an interface module. This module shall allow the FACP to be selected to function as either the XA loop master controller (head end) or as a Data Gathering Panel as an intelligent device on the XA loop reporting to a remote master controller. Multiple XA Loop Interface Modules can be installed in the FACP allowing a variety of system expansion situations to be satisfied.

D. REMOTE LCD ANNUNCIATOR

1. Provide where required a remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.
2. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
3. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

4. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
5. The LCD shall display the following information relative to the abnormal condition of a point in the system:
    a. 40 character custom location label.
    b. Type of device (e.g., smoke, pull station, waterflow).
    c. Point status (e.g., alarm, trouble).
6. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

E. EMERGENCY POWER SUPPLY

1. General: Components include battery, charger, and an automatic transfer switch.
2. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.

F. ADDRESSABLE MANUAL PULL STATIONS

1. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
2. Protective Shield: Where indicated on drawings, provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

G. SMOKE SENSORS

1. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
    a. Factory Nameplate: Serial number and type identification.
    b. Operating Voltage: 24 VDC, nominal.
    c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
    d. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.

e. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
f. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
g. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
h. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
i. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
j. Removal of the sensor head for cleaning shall not require the setting of addresses.

2. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Where acceptable per manufacturer specifications, ionization type sensors may be used.
3. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
4. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

a. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
b. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
c. Duct Housing shall provide a relay control trouble indicator Yellow LED.
d. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
e. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
f. Duct Housing shall provide a magnetic test area and Red sensor status LED.
g. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
h. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.
i. Where indicated provide a NEMA 4X weatherproof duct housing enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing

at its rated temperature range. The housing shall be UL Listed to Standard 268A.

H. HEAT SENSORS

1. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
2. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
3. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
4. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

I. ADDRESSABLE CIRCUIT INTERFACE MODULES

1. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.
2. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.
3. There shall be the following types of modules:
    a. Type 1: Monitor Circuit Interface Module:
        1) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
        2) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.
    b. Type 2: Line Powered Monitor Circuit Interface Module
        1) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
        2) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone

status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

c. Type 3: Single Address Multi-Point Interface Modules

1) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.

2) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.

3) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

d. Type 4: Line Powered Control Circuit Interface Module

1) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

e. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

1) This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

4. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

J. ADDRESSABLE ALARM NOTIFICATION APPLIANCES

1. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).

a. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on

the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.

b. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.

c. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.

2. Addressable Controller: Addressable Controller shall supervise Channel (SLC) wiring, communicate with and control addressable notification appliances. It shall be possible to program the High/Lo setting of the audible (horn) appliances by channel from the addressable controller.

3. Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

4. Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

5. Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:

   a. Synchronized Strobe with Horn on steady.
   b. Synchronized Strobe with Temporal Code Pattern on Horn.
   c. Synchronized Strobe with March Time cadence on Horn.
   d. Synchronized Strobe firing to NAC sync signal with Horn silenced.

6. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971

and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.

a. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC using and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
c. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
d. The S/V installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension.

7. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

   a. Report faults to the host FACP.
   b. On-board Yellow LED provides module status.
   c. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

8. Accessories: The contractor shall furnish the necessary accessories.

K. NAC Power Extender

1. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B Style Y rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
2. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
3. The NAC extender panel may be mounted close to the host control panel or can be remotely located. The IDNET Addressable NAC Extender Panel when connected to an addressable panel shall connect to the host panel via an IDNet communications channel. Via the IDNET channel each output NAC can be individually controlled for general alarm or selective area notification.
4. For IDNet connected NAC extender panels up to five panels can be connected on a single IDNet channel.
5. When connected to a conventional (non-addressable panel) one or two standard notification appliance circuits from the main control panel may be used to activate all the circuits on the NAC power extender panel.
6. Alarms from the host fire panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.

L. Circuit Conductors: Copper; power limited plenum rated; color code and label.

M. Dwelling Units: 120V stand-alone combination photo-electric smoke detector and carbon monoxide detector, with battery backup and sounder for alarm.

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac. Smoke detectors shall be powered from nearest receptacle branch circuit within room.
2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
4. Test Switch: Push to test; simulates smoke at rated obscuration.
5. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
6. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
7. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
8. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

N. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.

O. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.

1. Padlock eye and hasp for lock furnished by Owner.
2. Locate as directed by Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.

B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Fire Alarm System Installer shall be responsible for all electricals to their equipment/components.

D. Obtain Owner's approval of locations of devices, before installation.

E. Install instruction cards and labels.

F. Install and connect Fire Dept. Connection Horn and Light furnished by Sprinkler Contractor.

G. Install Fire Alarm System per construction phasing. Coordinate with Owner.

H. Coordinate integration between Owner & Owner's preferred third-party security/monitoring company.

3.2 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.

B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.

D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

E. Provide all tools, software, and supplies required to accomplish inspection and testing.

F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.

G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.3 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:

1. Hands-On Instruction: On-site, using operational system.

B. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:

1. Initial Training: 1 session pre-closeout.
2. Final Training: 1 session 90-days after closeout.

C. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.4 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.

1. Be prepared to conduct any of the required tests.

2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion of each associated phase.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:

1. Approved operating and maintenance data has been delivered.
2. Spare parts, extra materials, and tools have been delivered.
3. All aspects of operation have been demonstrated to Owner.
4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
5. Specified pre-closeout instruction is complete.

3.5 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:

1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:

1. Provide on-site response within 2 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

END OF SECTION 28 31 00

SECTION 31 23 16 – EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Excavation for buildings and other structural foundations.
2. Excavation for roads and walkways.
3. Excavation for site structures and utilities.

C. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 31 Section "Site Clearing".
3. Division 31 Section "Backfilling".

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

B. 29CFR - OSHA Construction Standards:

1. Part 1926 - Safety and Health Regulations for Construction – Subpart P - Excavations

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Section "General Requirements."

B. Shop Drawings: Submit a construction drainage plan showing the collection and disposal of surface and subsurface water that may be encountered in the course of construction.

C. Shoring Plan: Before excavating 5 feet or more in depth, submit a shoring plan in accordance with the requirements in Division 01 Section "General Requirements."

1.4 PROJECT CONDITIONS

1.5 Verify that survey benchmark and intended elevations for the Work are as indicated

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Underpin adjacent structures and roads which may be damaged by excavation work, including utilities and pipe chases.

B. Identify required lines, levels, contours, and datum.

C. Prior to penetrating any ground surface, obtain "Permit to Penetrate or Excavate Surfaces at LBNL" in accordance with Division 01 Section "Environmental, Safety, and Health Procedures". Forty eight hours notice is normally required from when a permit is requested to when it is issued; the Subcontractor is responsible for scheduling the permit request to suit construction activities. Identify known underground, above ground, and aerial utilities. Stake and flag locations.

D. Coordinate utility relocation or removal with the Project Manager.

E. Protect above and below grade utilities which are to remain. Support exposed utilities as needed.

F. Protect plant life, lawns, and other site features indicated to remain.

G. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

3.2 EXCAVATION

A. Excavate subsoil required to accommodate building foundations, slabs-on-grade, paving, utilities and site structures, construction operations. The maximum slope inclinations shall comply with OSHA.

B. Excavate to working elevation for piling or caisson work.

C. Machine slope banks to angle of repose or less, unless shored in accordance with the references cited in Divisions 01 Sections "General Requirements" and "Environmental, Safety, and Health Procedures".

D. Excavation cut not to interfere with normal 45 degree bearing splay of foundations.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Hand trim excavation as needed. Remove loose matter.

G. Remove lumped subsoil, boulders, and rock.

H. Notify the Project Manager promptly in writing of unexpected subsurface conditions before such conditions are disturbed and stop affected work in area until notified to resume work.

I. Correct unauthorized excavation at no extra cost to the University.

J. Correct areas over-excavated by error with lean concrete with a minimum 28 day compressive strength of 1,500 psi or in accordance with Division 31 Section "Backfilling".

K. Stockpile excavated material in area designated on site and remove excess material not being reused, from site. Cover stockpiled material to protect from rain. Take preventive measures to ensure that water containing soil from excavations or stockpiles does not enter storm drains.

3.3 FIELD QUALITY CONTROL

A. Field inspection will be performed under provisions of Division 01 Section "Special Provisions."

3.4 PROTECTION

A. Protect excavations by underpinning, sloping or shoring, as required to ensure life safety and protect property. Comply with applicable laws and standards.

B. Protect the bottom of excavations and soil within the 45° degree bearing splay of existing foundations.

END OF SECTION 31 23 16

SECTION 31 23 16 – TRENCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes trenching provisions to govern respective portions of Division 23 work.

B. Additional and other requirements, methods, and procedures for trenching required for particular systems are included in respective Sections. Specific requirements in respective specifications have precedence over general requirements in this Section.

1.2 REFERENCES

A. Following documents form a part of this specification to the extent indicated herein:

1. American Society of Testing Materials (ASTM).

a. D698 Standard Proctor Maximum Dry Density.
b. D2487 Classification of Soils for Engineering Purposes.
c. D2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 PROJECT/SITE CONDITIONS

A. Do not place frozen materials and do not place materials on a frozen or muddy surface.

PART 2 - PRODUCTS

2.1 BEDDING SAND

A. No. 24, Class B sand in accordance with INDOTSS 903, certificate required.

2.2 UNDERGROUND PIPING IDENTIFICATION TAPE

A. Tape: Polyethylene, 4 mil minimum thick, 3 inches wide with repeated black imprint, "CAUTION - (name of service)", a different distinctive fade resistant color for each service.

B. Reference Products

1. W.H. Brady, "Identoline".
2. EMEDCO, "Underground Warning Tape".
3. Services & Materials Co., "Underground Marking Tape".

PART 3 - EXECUTION

3.1 WORK

A. All trenching to be performed by the respective Contractor providing the installed materials.

3.2 EXAMINATION

A. Before commencing work; verify requirements for, and coordinate operations with, the following:

1. Installation of fences, including protective fencing for trees and plants.
2. Demolition of miscellaneous structures.
3. Clearing and grubbing.
4. Stripping and disposal of sod, and stripping and stockpiling of topsoil.

3.3 PREPARATION

A. Locate and mark all existing underground installations (utilities. etc.) in the area of operations.

B. Lay out the various lines on the ground using stakes and flags. Coordinate locations with existing underground installations and other work of this Division and other Divisions. Do not proceed with excavating until layout is approved.

C. Set line and grade stakes as required or specified in respective piping System Sections.

3.4 PROTECTION

A. Shore and brace excavations as necessary to prevent cave-ins.

B. Protection of Subgrade and Embankment.
1. During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along' subgrade in such manner as to drain effectively at all times.
2. Operate pumping equipment as required to keep excavation free of water and subgrades dry, firm, and undisturbed until permanent work has been approved by Architect.
3. Storage or stockpiling of materials on finished subgrade will not be permitted.

4. Erosion Control: Provide and perform erosion control as specified in Division 1 Section "Temporary Facilities" until permanent vegetation, structures and erosion control devices have been installed.

C. Protection of Topsoil Areas: After placement of topsoil, protect these areas from heavy machinery. Topsoil compacted by heavy machinery shall be removed and replaced at no additional cost to Owner.

3.5 TRENCHING

A. Trenching in General.

1. Perform excavating of every description, and of whatever substances are encountered, to depths indicated or required.
2. Excavation: By open cut, unless indicated otherwise, except short sections of a trench may be tunneled if pipe can be safely and properly installed and backfill can be properly compacted in tunnel sections.
3. Sheeting and Shoring: Placed as necessary for protection of work and safety of personnel.
4. Material Suitable for Backfill: During excavating, pile in an orderly manner a sufficient distance from banks of trench to avoid overloading and to prevent slides or cave-ins.
5. To prevent surface water from flowing into trenches or other excavations, perform grading as necessary.
6. Water Accumulating in Excavations: Remove by pumping or other acceptable methods.
7. Excavated Materials Not Required or Suitable for Backfill: Removed as waste materials.

B. Trench excavation.

1. Trench Width: As necessary for proper laying of pipe.

    a. Width of Trenches at All Points Below Top of Pipes: Not be greater than outside diameter of pipe plus 24 inches, nor less than outside diameter of pipe plus 12 inches, to permit satisfactory jointing and thorough tamping of bedding material under and around pipe.
    b. Sheeting and Bracing: Where required, place within specified trench width.
    c. Where Trench Widths are Exceeded: Provide stronger pipe or special installation procedures as directed without additional cost to Owner.

2. Banks of Pipe Trenches: As nearly vertical as practicable.
3. Bottom of Trenches: Accurately graded to provide a uniform surface for bedding at a depth not less than 1/3 the diameter of the pipe, 4 inches minimum, below bottom perimeter of pipe. Provide recesses in trench bottom to accommodate bells, joints, couplings, etc.
4. Stones: Remove as necessary to avoid point bearing.
5. Take care to not over excavate.

a. Except as specified for overexcavation due to wet, rocky or otherwise unstable material; backfill overdepths as specified for backfilling lower portion of trenches.
b. Wet or otherwise unstable material in bottom of trench that is incapable of properly supporting pipe shall be overexcavated to a depth to allow for construction of a stable pipe bedding.
c. When overexcavation is performed, backfill with a suitable material, compacted to a minimum of 4 inches below bottom and 4 inches on each side of pipe.

3.6 PAVEMENT REMOVAL AND REPLACEMENT

A. Remove and replace sidewalks, drives, etc. where required, as a part of respective mechanical installation work. Replace removed paving to match existing, and meet City specifications.

B. Pavement removal and replacement are governed by Division 1 Section "Cutting and Patching".

3.7 BEDDING

A. Deposit bedding sand in 6-inch maximum thickness layers in bottom of trench and compact to specified density with suitable tampers up to gradient of bottom of pipe.

B. As pipe is placed on bedding, deposit additional bedding sand on both sides of pipe and compact up to a layer thickness equal to 1/3 the diameter of pipe.

3.8 DISPOSITION OF WASTE MATERIALS

A. Remove waste materials from site and dispose of in a lawful manner.

END OF SECTION 31 23 16

SECTION 312323 – BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Building perimeter and site structure backfilling.
2. Site filling and backfilling.
3. Fill under slabs-on-grade and/or paving.
4. Consolidation and compaction.
5. Fill for over-excavation.

C. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 01 Section "Special Procedures."
3. Division 03 Section "Cast-in-Place Concrete."
4. Division 31 Section "Excavation".
5. Division 31 Section "Trenching".

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

B. ASTM International:

1. ASTM C136 Method for Sieve Analysis of Fine and Coarse Aggregates
2. ASTM D2992 Test Method for Density of Soil in Place by Nuclear Methods
3. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3(2,700 kN-m/m3))

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Section "General Requirements."

B. Submit a certified mix design and aggregate sieve analysis conforming with ASTM C136 for controlled density fill, if used.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Type A - Coarse Stone, Crushed Rock or Gravel: Free of shale, clay, friable material, sand, debris; graded in accordance with the Engineer's recommendations and a cleanness value of 75 or greater.

B. Type B - Class 2, Aggregate Base: Free of vegetable matter and other deleterious substances, and shall be of such nature that it can be compacted readily using water, tamping and rolling to form a firm, stable base.

C. Type C - Pea Gravel: Washed, free of clay, shale, organic matter; graded in accordance with the Engineer's recommendations and have a cleanness value of 75 or greater.

D. Type D - Sand: Natural river or bank sand; or washed sand free of silt, clay, loam, friable or soluble materials, or organic matter; graded in accordance with ASTM C136 and having a sand equivalent of 75.

E. Type E - Imported Backfill: Nonexpansive soil, free of debris, organic material and clods or rocks larger than 4 inches with a liquid limit no greater than 40 and a plasticity index no greater than 15.

F. Type F - Native Backfill: "As is", free of debris, organic material and clods or rocks larger than 4 inches.

G. Water: Free of objectionable quantities of silt, oil, organic matter, alkali, or salts.

H. Controlled Density Fill: Controlled density fill will be considered an acceptable alternative to Type E or F backfill at the Subcontractor's option.

2.2 CONTROLLED DENSITY FILL

A. Controlled Density Fill Mix: Consisting of portland cement, fly ash, water, fine and course aggregate and an air entraining admixture. The proportions of the controlled density fill shall conform to the mix design. Controlled density fill shall have a 28 day unconfined compressive strength from a minimum of 50 psi to a maximum of 150 psi.

B. Aggregates that produce the performance characteristics of the control density fill may be submitted for approval. The maximum size aggregate is 3/8-inch; the quantity of aggregate material passing a #200 sieve shall not exceed 12 percent.

C. Air Content: Not to exceed 6 percent when measured in conformance with ASTM C231.

2.3 ACCESSORIES

A. Geotextile Fabric: Mirafi, Exxon, or equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Control dust throughout backfill operations.

B. Compact subgrade to density requirements for subsequent backfill materials. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with the type of material indicated on the Drawings and compact to density equal to or greater than requirements for subsequent backfill material.

C. Prior to placement of aggregate base course material at paved areas, compact subsoil to 95 percent of its maximum dry density at optimum water content –1 percent + 3 percent in accordance with ASTM D1557 to the depth as indicated on the Drawings, but not less than 6 inch.

3.2 BACKFILLING

A. Backfill areas to contours and elevations with specified materials.

B. Systematically backfill by mechanical means. Do not backfill over porous, wet, or spongy subgrade surfaces.

C. Place geotextile fabric as shown on the drawings.

D. Type A, C or D Fill: Place and compact materials in continuous layers not exceeding 6 inch compacted depth.

E. Type B Fill - Aggregate Base Class 2: Placement of aggregate base shall not proceed until the Subcontractor has obtained the Owner approval for compaction and grading of the subbase.

F. Type E or F Fill: Place and compact material in continuous layers not exceeding 6 inch compacted depth under structures, roads or site structures, and eight inches compacted depth in other areas.

G. Employ a placement method that does not disturb or damage foundation perimeter drainage or foundation waterproofing.

H. Maintain moisture content of backfill materials within –1 percent to +3 percent of optimum to attain required compaction density.

I. Slope grade away from building minimum two inches in 10 ft, unless noted otherwise.

J. Make grade changes gradual. Blend slope into level areas.

K. Remove surplus excavated materials from site.

L. Leave fill material stockpile areas completely free of excess fill materials.

3.3 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: The surface of the finished aggregate base at any point shall not vary more than 1/2-inch above or below the grade shown on the Drawings.

3.4 PROTECTION OF FINISHED WORK

A. Protect finished work.

B. Recompact fills subjected to vehicular traffic.

3.5 SCHEDULE (unless otherwise noted on the Drawings)

A. One foot wide layer on exterior side of foundation walls, and behind retaining walls and over foundation perimeter drainage.

1. Filter fabric and Type A fill to subgrade elevation, compacted in six-inch lifts with each lift compacted to 95 percent.

B. Below unpaved areas on exterior side of foundation walls, and behind retaining walls and over foundation perimeter drainage.

1. Type E or F fill to subgrade elevation compacted in six inch lifts with each lift compacted to 90%.

C. Fill Under Grass Areas:

1. Type E or F fill, to 6 inch below finish grade, compacted in six inch lifts with each lift compacted to 90 percent.

D. Fill Under Landscaped Areas:

1. Type E or F fill, to 12 inches below finish grade, compacted in six inch lifts with each lift compacted to 90%.

E. Fill Under Asphalt or Concrete Paving:

1. Type B fill, to subgrade elevation, compacted in six inch maximum lifts with each lift compacted to 95 percent.

END OF SECTION 31 23 23

SECTION 32 13 13
PORTLAND CEMENT CONCRETE PAVING

1 General

1.1 Section Includes

A. Concrete sidewalks, curbs, gutters, and drives.

B. Decorative concrete walks, exposed aggregate.

C. Reinforcement.

D. Surface finish.

E. Curing.

1.2 Related Sections

A. Section 31 20 00 - Earthwork.

B. Section 32 11 16 - Granular Base Course: Prepared base.

C. Section 32 17 23 - Roadway and Paving Marking: Pavement marking.

1.3 References

A. ACI 301 - Specifications for Structural Concrete for Buildings.

B. ASTM A185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

C. ASTM A497 - Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.

D. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

E. ASTM C31 - Making and Curing Concrete Test Specimens in the Field.

F. ASTM C33 - Concrete Aggregates.

G. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

H. ASTM C94 - Ready-Mixed Concrete.

I. ASTM C150 - Portland Cement.

J. ASTM C260 - Air-Entraining Admixtures for Concrete.

K. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.

L. ASTM C494 - Chemical Admixtures for Concrete.

M. ASTM C618 - Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

N. ASTM C1116 - Fiber-Reinforced Concrete and Shotcrete.

O. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds having Special Properties for Curing and Sealing Concrete.

P. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Type).

Q. ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.4 Regulatory Requirements

A. Conform to applicable __ code for paving work on public property within the right-of-way.

1.5 Quality Assurance

A. Pervious Concrete Installer Qualifications: A qualified installer who employees on project personnel that are NRMCA and IRMCA Pervious Concrete Certified.

B. Perform work in accordance with ACI 301.

C. Obtain materials from same source throughout.

D. Testing and analysis will be performed under provisions of Division 1.

E. Testing firm's ACI certified technician will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

F. Perform tests of cement and aggregates to ensure conformance with requirements stated herein.

G. Take three concrete test cylinders for every 5075100 or less cubic yards of each class of concrete placed each day.

H. Take one additional test cylinder during cold weather and cure on site under same conditions as concrete it represents.

I. Take one slump test for each set of test cylinders taken.

1.6 Submittals

A. Submit product data and manufacturer's instructions under provisions of Division 1.

B. Include data on joint filler, admixtures, and curing compounds.

C. Submit proposed mix design of each class of concrete to Architect for review prior to commencement of work.

D. For all concrete mixes using fly ash, submit the following:

1. Certified letter stating that all fly ash being used meets all requirements of ASTM C618, except that the maximum loss on ignition shall be 3 percent.

2. Laboratory test results for each mix being submitted.

E. Qualification Data: For Pervious Concrete Installers indicating NRMCA and IRMCA certifications.

2 Products

2.1 Portland Cement Concrete Paving Materials

A. Cement: ASTM C150 Normal-Type I Air Entraining-Type IA Air Entraining-Type IIA Air Entraining-Type IIIA Sulfate Resistant-Type V Portland type, gray color.

B. Fly Ash: ASTM C618, Type C.

C. Fine and Coarse Aggregates: ASTM C33.

D. Number 57 Multi-colored River Blend Aggregate.

E. Water: Clean and not detrimental to concrete.

2.2 Form Materials

A. Conform to ACI 301.

B. Wood or steel form material, profiled to suit conditions, except for curb forms, which shall be steel.

2.3 Reinforcement

A. Reinforcing Steel: ASTM A615; 60 ksi yield grade; deformed billet steel bars, uncoated __ finish.

B. Welded Steel Wire Fabric: Plain type, ASTM A185 uncoated finish.

C. Tie Wire: Annealed steel, minimum 16__ gage size.

D. Dowels: ASTM A615; 60 ksi yield grade, plain steel, uncoated finish.

E. Fiber Additive: Complying with ASTM C1116.

1. Nylon Fibers: 100 percent virgin nylon, 3/4 inch length fiber unless otherwise noted.

a. FORTA NYLON as manufactured by Forta Corporation, with a dosage rate of 1.0 pound per cubic yard of concrete.

b. NYCON as manufactured by Nycon, Inc., with a dosage rate of 1.0 pound per cubic yard of concrete.

2. Polypropylene Fibers: 100 percent virgin collated, fibrillated, polypropylene fibers, 3/4 inch length unless otherwise noted.

    a. FIBERMESH as manufactured by Fibermesh Co., with a dosage rate of 1.5 pounds per cubic yard of concrete.

    b. FORTA CFP as manufactured by Forta Corporation, with a dosage rate of 1.5 pounds per cubic yard of concrete.

2.4 Accessories

A. Curing Compound: ASTM C309.

1. Kurez DR as manufactured by Euclid Chemical Company.

2. L&M Cure as manufactured by L&M Construction Chemicals, Inc.

B. Curing and Sealing Compound: Clear styrene acrylate type, 30 percent solids content minimum, ASTM C1315, Type 1, with test data from an independent testing laboratory indicating a maximum moisture loss of 0.030 grams per square centimeter when applied at a coverage rate of 300 square feet per gallon.

1. Super Rez Seal or Super Pliocure as manufactured by the Euclid Chemical Company.

2. Dress & Seal #30 as manufactured by L & M Construction Chemicals, Inc.

3. Masterseal 66 as manufactured by Master Builders.

4. Manufacturer's certification required.

C. Preformed Joint - Joint Filler: ASTM D1751, D1752, type; 1/23/4 inch thick.

D. Paving Joint Sealant: One part, non-priming, self-leveling, polyurethane joint sealant; gray color.

1. Sonolastic SL-1.

2. Eucolastic I as manufactured by Euclid Chemical Co.

E. Curb Joint Sealant: Two Part Sonolastic as manufactured by Sonneborn or approved equal; gray __ color.

2.5 Admixtures

A. Air Entrainment: ASTM C260.

B. Chemical Admixture: ASTM C494.

C. Prohibited Admixtures:

1. Calcium chloride, thiocyanates, or admixtures containing more than 0.05 percent chloride ions.

2.6 Concrete Mix

A. General: Design mix for the least amount of water consistent with workability and finishing requirements.

1. Do not exceed 4 inches slump.

B. Mix concrete in accordance with ASTM C94.

C. Mix Proportions:

1. For concrete mixes not containing fly ash, the minimum cement content per cubic yard of concrete shall be as follows.

a. 6 1/2 bags (611 pounds) for 4500 psi concrete.

b. 5 bags (470 pounds) for 3000 psi concrete.

c. 6 bags (564 pounds) for 4000 psi concrete.

2. Proportion the fine aggregate between a minimum of 35 percent and a maximum of 45 percent of the total aggregate weight and utilizing the maximum amount of coarse aggregate within these limits that is consistent with the desired workability.

3. Coarse Aggregate: Crushed limestone.

4. Air Content: 4.5 percent to 7.5 percent

5. Maximum Water/Cementitious Materials Ratio (W/C): 0.45.

6. Twenty-Eight Day Compressive Strength: 4500__ psi.

7. For mixes using fly ash, a maximum of 15 percent by weight of the cementitious material may be fly ash.

D. Use accelerating admixtures in cold weather only when approved by Architect/EngineerConstruction Manager.

1. Use of admixtures will not relax cold weather placement requirements.

E. Use set-retarding admixtures during hot weather only when approved by Architect/EngineerConstruction Manager.

F. Add air entraining agent to concrete mix for concrete work subject to freeze/thaw cycling.

G. Add fiber additive at the batching plant at rate specified in Part 2 above.

2.7 Exposed Aggregate Concrete Mix

A. General: Design mix for the least amount of water consistent with workability and finishing requirements.

1. Do not exceed 4 inches slump.

B. Mix concrete in accordance with ASTM C94.

C. Mix Proportions:

1. Concrete mix can not contain fly ash.

a. 6 bags (564 pounds) for 4000 psi concrete.

2. Proportion the fine aggregate between a minimum of 35 percent and a maximum of 45 percent of the total aggregate weight and utilizing the maximum amount of coarse aggregate within these limits that is consistent with the desired workability.

3. Main Coarse Aggregate: Crushed limestone.

4. Decorative Aggregate: #57 River Multi-Colored Blend, either substituted fully into Aggregate mix, or 'Seed' into surface of the Concrete.

5. Air Content: 4 percent to 6 percent

6. Maximum Water/Cementitious Materials Ratio (W/C): 0.45.

7. Twenty-Eight Day Compressive Strength: 4000 psi.

D. Use accelerating admixtures in cold weather only when approved by Architect/EngineerConstruction Manager.

1. Use of admixtures will not relax cold weather placement requirements.

E. Use set-retarding admixtures during hot weather only when approved by Architect/EngineerConstruction Manager.

F. Add fiber additive at the batching plant at rate specified in Part 2 above.

3 Execution

3.1 Existing Conditions

A. Verify compacted subgrade granular base stabilized soil is ready to support paving and imposed loads.

1. Provide surfaces free of frost, ice, mud, and water.

B. Verify gradients and elevations of base are correct.

C. Beginning of installation means acceptance of existing conditions.

3.2 Preparation

A. Moisten base to minimize absorption of water from fresh concrete.

B. Notify Architect/EngineerConstruction Manager minimum forty-eight (48) hours prior to commencement of concreting operations.

3.3 Forming

A. Place and secure forms to correct location, dimension, and profile.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint fillers vertical in position, in straight lines.

1. Secure to formwork during concrete placement.

3.4 Reinforcement

A. Place reinforcement at mid-height top bottom top and bottom of slabs-on-grade.

B. Interrupt reinforcement at expansion contraction joints.

C. Place reinforcement to achieve slab and curb alignment as detailed.

D. Provide doweled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.5 Joints

A. Space joints in accordance with the following table and as indicated on Drawings:

Maximum Spacing for Pavement Type			
Joint Type	Drives, Parking	Sidewalks	Curbs
Control	12'_	10'_	10'
Expansion	As approved by the ArchitectAs indicated on Drawings	30'_	30' and at all returns
Longitudinal	12'_ Construction	--	

B. Place joints at correct elevation and profile.

1. Align curb, gutter, and sidewalk joints.

C. Install joint filler with sealant at intersections with another sidewalk, between sidewalks and buildings, and at such other locations as indicated on the Drawings.

1. Recess top of filler 1/2 inch for sealant placement.

3.6 Placing Concrete

A. Place concrete in accordance with ACI 301.

B. Hot Weather Placement: ACI 301.

C. Cold Weather Placement: ACI 301.

D. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.

E. Place concrete continuously between predetermined construction joints.

1. Do not break or interrupt successive pours such that cold joints occur.

F. Consolidate all concrete by vibration, spading, rodding or forming so that the concrete is thoroughly worked around the reinforcement, around embedded items and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness.

G. Use saw cut joints only for drive or road paving.

1. Do not use saw cut joints on curbs and sidewalks.

H. Place concrete to pattern indicated.

1. Hand tool or saw cut control joints 3/16__ inch wide.

2. Cut 1/3 into depth of slab.

3. Saw cut as soon as concrete has hardened sufficiently to prevent excessive raveling, usually within 4 to 24 hours.

4. Clean joints by vacuum or airblast after sawing.

I. Decorative Concrete, whether full aggregate used or 'Seeded' with aggregate, provide for uniformly spread aggregate on surface and using bull float or darby until surface stone is covered by the thin layer of cement paste. Follow industry standards for completing full exposed effect of the River Blend aggregate.

3.7 Finishing

A. Sidewalk Paving: Light broom, radiused and trowel joint edgesWood float__.

B. Curbs and Gutters: Light broom__.

C. Place curing compound on exposed concrete sidewalk surfaces immediately after finishing.

1. Place curing and sealing compound on exposed concrete paving and curb surfaces immediately after finishing.

2. Apply in strict accordance with manufacturer's instructions.

D. Finish pervious concrete in accordance with NRMCA and IRMCA recommendations.

3.8 Field Quality Control

A. Perform field inspection and testing under provisions of Division 1.

B. Maintain records of placed concrete items.

1. Record date, location of pour, quantity, air temperature, and test samples taken.

C. Variation From True Elevation: Within 1/2__ inch.

D. Variation From Designated Thickness: Within 1/4 inch.

E. If tests or inspection indicate work does not meet specified requirements, remove work and replace at no cost to the Owner.

3.9 Protection

A. Immediately after placement, protect concrete under provisions of Division 1 from premature drying, excessive hot or cold temperatures, and mechanical injury.

END OF SECTION

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. All new & disturbed lawn areas shall be sodded, using sod species approved by Vincennes University Grounds Department - seeding/strawing shall not be allowed. Any landscaping beds, as indicated on construction drawings, shall be installed by others. Provide for watering & maintenance, as necessary, until new sod is established.

B. Section Includes:

1. Sodding.

C. Related Sections:
1. Section 312000 "Earth Moving" for excavation, filling and backfilling, and rough grading.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

B. Product Certificates: For fertilizers, from manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, and soil amendments with appropriate certificates.

1.6 PROJECT CONDITIONS

A. Planting Restrictions: Provide sod installation within 14 calendar days of backfilling/compacting excavations & trenches. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.7 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Sodded Turf: 30 days from date of planting completion.

2. **Provide for regular watering of all new sod, and do not expect Owner's irrigation system to be operational for the sod watering period.**

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species:

1. Species: To be approved by Vincennes University Grounds Dept.

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: To be approved by Vincennes University Grounds Dept.

2.3 PLANTING SOILS

A. Planting Soil: Existing, in-place surface soil. Verify suitability of existing surface soil to produce viable planting soil. Remove stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

B. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydro-seeding and hydro-mulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.

3. Remove stones larger than 1 inches in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus ½ inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor re-grading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.6 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 32 92 02 – RESTORATION OF SURFACES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Restoration of surfaces shall include the removal of the existing surface, the disposal of the surplus material and the construction of new surfaces and adjusting all new and existing structures for proper grade prior to paving as indicated on the plans and/or as specified in these Specifications.

1.2 RESTORATION OF PAVED SURFACES

A. Restoration

1. After all excavations within the limits of paved surfaces have been properly backfilled, compacted and repaired, the paved surfaces shall be restored to a condition as good as or better than existed prior to the beginning of the work, in accordance with the following specifications.
2. State Paved Surfaces: Highways, streets and roads constructed and/or maintained by the Indiana Department of Transportation (INDOT), which are wholly or partially removed, damaged or disturbed by the Contractor's operations shall be restored to a condition as good as or better than existed prior to the beginning of the work. Such restoration shall be performed in accordance with the pertinent specifications and standards of the Indiana Department of Transportation, as applicable.
3. Other Paved Surfaces: Streets, alleys, sidewalks, driveways, curbs and gutters, not constructed or maintained by the Indiana Department of Transportation, but paved with asphalt, concrete, cinders, crushed stone, waterbound macadam, oil-bound macadam, or heterogenous paving materials, which are wholly or partially removed, damaged, or disturbed by the Contractor's operations, shall be restored with like or better materials, acceptable to the Engineer, to a condition as good as or better than existed prior to the beginning of the work, so that movement of traffic, both vehicular and pedestrian, through the restored way shall be as free, safe and unimpeded as before.

B. Temporary Surface

1. Temporary trench surfaces shall be installed and maintained in accordance with this specification. This temporary surface shall be maintained by the Contractor until the permanent pavement is placed. Before placing permanent pavement, all or parts of the temporary surface shall be removed, as necessary, and hauled from the site of the work.

PART 2 - PRODUCTS

2.1 TEMPORARY PAVEMENT REPLACEMENT

A. Trench surfaces of highly traveled streets and roads may be designated to receive a temporary pavement replacement of cold mixed bituminous pavement. This temporary pavement shall be of the thickness specified or shown on the plans and shall be surface mixture Class A or B prepared and placed in accordance with Section 403 - Cold Mixed Asphalt, CMA, Pavement of the latest edition of the INDOT Standard Specifications. Prime and tack coats shall not be required. All temporary pavement shall be maintained by the Contractor to proper grade so as not to impede the safe flow of traffic until the permanent pavement replacement is made.

2.2 PERMANENT PAVING

A. Permanent paved surfaces shall be restored in accordance with "Roadways and Parking Areas" and the following requirements, unless otherwise set forth in the plans, the Special Provisions or Detailed Specifications; however, in all cases, the methods and materials of restoration shall meet the requirements of the INDOT, as applicable.

2.3 RESTORATION OF GROUND SURFACES

A. All ground surfaces in public Rights-of-Way, easements and on private property that have been damaged or destroyed by the Contractor's operations shall be restored in accordance with the following specifications. All surplus material, rock, trees, shrubs, concrete pipe, asphalt, crushed stone, etc., not to be used in the Contractor's restoration operations shall be removed from the site and disposed of in an acceptable manner. All work, either sodding or seeding and mulching, shall be in accordance with WM-24, "Seeding and Sodding".

2.5 CLEAN UP

A. Before final acceptance of the work, the Contractor shall satisfactorily clean all areas within the limits of his operations including the street surfaces, walks, gutters, fences, lawns, private property and structures, leaving them in as neat, clean and usable condition as originally found. He shall remove all machinery, tools, surplus materials, temporary buildings and other structures from the site of work. He shall also remove all organic matter and materials containing organic matter from all areas and places used by him during construction. All pipes, manholes, inlets, etc., shall be cleared of all scaffolding, sedimentation, debris, rubbish and dirt.

B. Where the Contractor's operations have resulted in filling existing ditches, clogging existing culverts, damaging existing bridges, ground surfaces, sidewalks, driveways, etc., the Contractor shall re-ditch, clean culverts, repair or replace bridges, ground surfaces, sidewalks, driveways, etc. so as to return them to a condition as good as or better than existed prior to the beginning of his operations.

C. The Contractor's cleanup operations, which include repair, restoration or replacement of ground surfaces and existing improvements and the removal of rock, shall be performed continuously during the construction operations.

D. All cleanup and restoration shall be done to the approval of Vincennes University.

E. Contractor shall prepare curb, and provide for (2) coats of yellow traffic paint on both east & west First Street curbs, for the entire length between decorative concrete walkways on each side of Godare Hall.

END OF SECTION 32 92 02

SECTION 33 30 00
SANITARY SEWAGE SYSTEMS

1 General

1.1 Section Includes

A. Sanitary drainage piping, fittings, and accessories.

B. Connection of building sanitary sewer system to municipal sewers.

C. Manholes and cleanout access.

D. Grease Interceptor.

1.2 Related Sections

A. Section 31 20 00 - Earthwork: Trenching and Backfill.

B. Section 33 40 00 - Storm Sewage System.

1.3 References

A. ASTM C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

B. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

C. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

D. ASTM C923 - Resilient Connections Between Concrete Manhole Structures and Pipes.

E. ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

F. ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

G. INDOT Standards - 2020 Indiana Department of Transportation Standard Specifications, including Supplements.

1.4 Regulatory Requirements

A. Conform to Indiana __ Plumbing Code for materials and installation of the Work of this Section.

1.5 Submittals

A. Submit product data under provisions of Division 1.

B. Submit product data for pipe, pipe accessories, castings and cleanouts.

C. Submit shop drawings for manholes.

D. Submit test results.

1.6 Project Record Documents

A. Submit documents under provisions of Division 1.

B. Accurately record location of pipe runs, connections, manholes, cleanouts, and invert elevations.

1. Maintain accurate record documents drawings as project progresses, on a set of project drawings.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Within 10 days of this installation, submit one electronic file and one mylar drawing, certified by licensed engineer or surveyor, indicating date, and labeled "As-Built Drawings."

2 Products

2.1 Sewer Pipe Materials

A. Plastic Pipe: ASTM D2672, SDR-26, heavy wall with gasket belled ends, PolyVinyl Chloride (PVC) material;

B. Plastic Pipe: ASTM D1785 Schedule 40 PolyVinyl Chloride (PVC) material, bell and spigot and joints.

2.2 Pipe Accessories

A. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required 'T', bends, elbows, cleanouts, reducers, traps, and other configurations required.

2.3 Manholes

A. Lid and Frame: Cast iron construction, removable self-sealing gasket lid, closed lid design with "SANITARY SEWER" in 2 inch high letters cast in top, model number as noted on Drawings.

B. Shaft Construction and Eccentric Cone Top Section: ASTM C478, reinforced precast gasketed concrete pipe sections, lipped male/female gasketed joints, and mastic coating.

1. Cast steel plastic covered 10 inch ladder rungs properly anchored into shaft on 16 inches centers.

C. Base Pad: Precast reinforced concrete; leveled top surface to receive concrete shaft sections, sleeved to receive sewer pipe sections, with ASTM C923 resilient waterproof manhole connections.

1. First shaft section to be integral with base pad.

D. Waterproof Mastic: ¾" x" RX Expansion waterstop CS-231.

3 Execution

3.1 Examination

A. Contractor shall coordinate with City of Vincennes Waste Water Department for on-site inspection by Waste Water Department during installation of mains and lateral connections.

B. Verify that trench cut is ready to receive work, and excavations, dimensions, and elevations are indicated on Drawings.

C. Beginning of installation means acceptance of existing conditions.

3.2 Preparation For Sanitary Sewage Systems

A. Hand trim excavations to required elevations.

1. Correct over excavation with fill material.

B. Remove large stones or other hard matter which could damage sewer pipe or impede consistent backfilling or compaction.

3.3 Installation - Pipe

A. Install pipe, fittings, and accessories in accordance with applicable codes and manufacturer's instructions.

1. Seal joints watertight.

B. Lay pipe to slope gradient noted on Drawings.

C. Increase compaction of each successive lift.

1. Refer to Section 31 20 00 for compaction requirements.

2. Do not displace or damage pipe when compacting.

D. Connect to building sewer outlet and municipal sewer system.

E. Install bell and spigot pipe with bell end facing upstream, and spigot end facing downstream.

F. Install minimum 14 gauge tracer wire on mains and laterals.

G. Install anti-seep earth or flowable-fill collar at the midpoint between manholes.

H. Do not lay water lines, storm, and sanitary sewers in the same trench.

1. Maintain a horizontal separation of 10 feet.

I. Avoid crossings of buried sewers and water lines.

1. However, where crossings are necessary, maintain a minimum of 18 inches vertical clearance (measured from the bottom of the upper pipe to the top of the lower pipe), preferably with the water main above the sewer.

J. When it is impossible to maintain proper horizontal and vertical separation, construct the sewer of waterworks grade ductile iron pipe with mechanical joints, and pressure test to assure water tightness prior to backfilling.

1. Install in accordance with AWWA C600.

3.4 Installation - Manholes

A. Form bottom of excavation clean and smooth to correct elevation.

B. Place precast concrete base section, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverted for inlets and outlets as indicated.

D. Construct semi-circular flow channel with change in direction having as large a radius as possible by formed concrete.

1. Slope floor of manhole outside channels not less than 1/2 inch per foot nor more than 2 inches per foot.

E. Coat entire exterior surface of manhole with waterproof mastic applied in accordance with manufacturer's recommendations.

F. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

G. Free drop in manhole not to exceed 24 inches, from invert of inlet to top of floor outside flow channels.

1. Construct drop manhole if free drop is greater than 24 inches.

H. Install adjusting rings where required to meet grade shown on Drawings, but not to exceed 12 inches maximum. Seal opening between pipe and structure with non-shrink grout. Smooth grout on inside and outside of structure to smooth and neat appearance. After grout is cured, apply waterproof mastic coating on inside and outside of structure.

3.5 Field Quality Control

A. Perform field inspection under provisions of Division 1.

B. Provide infiltration or exfiltration tests in accordance with Ten States Standards for design and construction of storm and sanitary sewers.

C. Provide all tests and inspections as required by local authorities. All testing to be supervised by City of Jasper Waste Water Department.

D. Provide mandrel test for PVC pipe.

E. Gravity Sewers:

1. Mandrel test all gravity sewers constructed of flexible pipe (PVC and/or HPDE) and truss pipe no sooner than thirty (30) days after installation.

2. Test all gravity sewers for infiltration by means of a low pressure air test in accordance with ASTM F1417.

F. Inspection and Testing of Manholes:

1. Inspect and test manholes for watertightness or damage prior to placing into service. Conform to air test procedures described in ASTM C1244.

3.6 Protection

A. Protect finished installation under provisions of Division 1.

B. Protect pipe from damage or displacement until backfilling operation is in progress.

3.7 Cleaning Sanitary Sewer System

A. Clear interior of piping of dirt and other superfluous material as work progresses.

1. Maintain swab or drag in line and pull past each joint as it is completed.

B. In large, accessible piping, brushes and brooms may be used for cleaning.

C. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

D. Flush lines between manholes if required to remove collected debris.

E. Keep installed system clean and clear from debris and blockage during construction and perform a final cleaning upon completion and before acceptance of system.

END OF SECTION